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Creation of Value with Open Source Software in the Telecommunications Field

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Abstract

Over the last ten years, Open Source software has moved from typical research and development environments to the enterprise sector, where it is competing against very successful proprietary software in a lot of domains as Internet, industry and financial services. Open Source software can offer both cost reductions and improvements in software quality. However, the uptake by incumbent telecommunications providers has been residual due to prior strategic investments made on proprietary software and perceptions over Open Source risks.

Many recent projects confirm the potential of Open Source in the telecommunications field. Among them, we can highlight the New Generation Operation Support Systems (NGOSS), the OpenOSS initiative and the OpenClovis software project. However, the most important study, at the present moment, about the use and impact of Open Source software in telecommunications was promoted by Eurescom. The project analyzed the phenomenon of Open Source software from a telecommunications operator's perspective. The results of the study show that Open Source software has become a very successful alternative to traditional software in many areas, from both a technical and an economical point of view, and should be included in all Public Network Operators' (PNOs) business strategies. In that study, the consortium proposed a generic Open Source business roles model with assigned roles and relationships, and identified various Open Source business models that are particularly suitable for adoption in the telecommunications domain.

One of the most important decisions for any telecommunications company that addresses Open Source solutions is to know its correct positioning in the telecommunications value chain and the right relationships with all stakeholders. To help companies in this task, this dissertation extends and instantiates the generic Open Source business roles model proposed by Eurescom: to take into consideration the new emergent technologies in the market such as, IPv6, IMS, VoIP and Ad-hoc Networks; to facilitate the relationships between universities/research centers and private companies; and to be easily explored by technologic-based start-up companies. The extended model presented in this dissertation proposes ten roles and certain relationships between the protagonists of the model and its instantiations. The Open Source Consultant, Quality Certification Entity, Training Provider and Portal Provider were new roles introduced in this extension.

The new extended Open Source business roles model is instantiated for three representative and emergent scenarios: unified communications solution, VoIP solution and IMS based services. The Osterwalder methodology is used to describe the value chain and analyze the business model that supports each scenario. This methodology follows a three tier approach: firstly, it decomposes the business model into nine business components; secondly, it assesses the business model using the SWOT analysis and a package of key pertinent questions; thirdly, it tries to identify the potential innovation and improvement paths. The first scenario proposes the creation of a unified communications solution based on OS software and open standards that addresses the Small and Medium Businesses (SMBs) market. The proposed solution explores the open innovation paradigm to establish a close relationship between

private companies and universities/R&D centers. The second scenario proposes the introduction of a VoIP service. It suggests the use of the Asterisk platform, identifies a relevant role to be performed by Training Providers and Quality Certification entities, and identifies the most adequate distribution channels to address international markets. Finally, the third scenario uses the IMS approach to deliver a converged fixed-mobile solution composed by a different wide range of applications that will reduce the time-to-market of multimedia solutions and the complexity of the system decreasing the Capital Expenditure (Capex) and the Operational Expenditure (Opex).

Resumo

Nos últimos dez anos, o software de código aberto tem passado dos ambientes típicos de investigação e desenvolvimento para o sector empresarial, onde se encontra a competir com software proprietário de grande sucesso num extenso conjunto de domínios, como a Internet, indústria e serviços financeiros. Embora o software de código aberto permita oferecer simultaneamente redução de custos e melhorias na qualidade do software, a sua ascensão junto dos actuais provedores de telecomunicações tem sido residual devido aos investimentos estratégicos por eles já realizados em software proprietário e à percepção dos riscos associados ao software de código aberto.

Muitos projectos recentes confirmam o potencial do software de código aberto no sector das telecomunicações. Dentre eles, podemos destacar o projecto New Generation Operation Support Systems (NGOSS), a iniciativa OpenOSS e o projecto OpenClovis. Todavia, o estudo de maior importância, até ao presente momento, sobre o uso e impacto do software de código aberto nas telecomunicações foi promovido pelo Eurescom. O projecto analisou o fenómeno do software de código aberto na perspectiva de um operador de telecomunicações. Os resultados do estudo mostram que o software de código aberto tem-se tornado uma alternativa de sucesso ao uso de software tradicional em inúmeras áreas, em ambas as dimensões técnica e económica, e deveria fazer parte da estratégia de todos os operadores públicos de rede. Nesse estudo, o consórcio propôs uma plataforma genérica de negócios em software de código aberto, identificando entidades, tarefas e relações, para além de diferentes modelos de negócio em software de código aberto que são particularmente adequados para serem adoptados no domínio das telecomunicações.

Uma das decisões mais importantes para uma empresa de telecomunicações que forneça soluções de código aberto é saber o seu correcto posicionamento dentro da cadeia de valor das telecomunicações e as adequadas relações com todos os participantes. Para ajudar as empresas nesta tarefa, esta dissertação estende e instancia a plataforma genérica de negócios em software de código aberto proposto pelo Eurescom, no sentido de: tomar em consideração as novas tecnologias emergentes no mercado como o IPv6, IMS, VoIP e redes *Ad-hoc*; facilitar as relações entre as universidades/centros de investigação e empresas privadas; ser facilmente explorada por novas empresas de base tecnológica. O modelo estendido apresentado nesta dissertação propõe dez papéis e certas relações entre os protagonistas do modelo e as suas instanciações. Esta extensão introduz como novas entidades o consultor de software de código aberto, a entidade de certificação de qualidade, o fornecedor de formação e o fornecedor de portal.

A versão estendida da framework de negócios em software de código aberto foi instanciada para três cenários representativos e emergentes: solução de comunicações unificadas, solução de VoIP e serviços baseados em IMS. A metodologia de Osterwalder é usada para descrever a cadeia de valor e analisar o modelo de negócio que suporta cada cenário. Esta metodologia segue uma abordagem de três camadas: primeiramente, decompõe o modelo de negócio em nove componentes de negócio; em seguida, avalia o modelo de negócio usando a análise SWOT e um conjunto de questões-chave pertinentes; finalmente, tenta identificar o potencial

inovador e caminhos de aperfeiçoamento. No primeiro cenário é proposto a criação de uma solução de comunicações unificadas baseadas em software de código aberto e padrões abertos que endereça o mercado das pequenas e médias empresas (PMEs). A solução proposta explora o paradigma da inovação aberta e estabelece uma relação estreita entre empresas privadas e as universidades/centros de investigação. O segundo cenário propõe a introdução de um serviço de VoIP. Sugere-se o uso da plataforma Asterisk, identifica-se um papel relevante para ser desempenhado pelos fornecedores de formação e entidades de certificação de qualidade, e identificam-se os canais de distribuição mais adequados a serem usados no endereçamento do mercado internacional. Finalmente, o terceiro cenário usa a abordagem IMS para providenciar uma solução fixa-móvel convergente constituída por um grande e diversificado número de aplicações. Esta solução irá reduzir o tempo de entrada no mercado de soluções multimédia e a complexidade do sistema, reduzindo assim os custos de capital (Capex) e os custos operacionais (Opex).

Résumé

Au cours de ces dix dernières années, le logiciel libre est passé du secteur de recherche et de développement au secteur de l'entreprise, où il entre en concurrence avec des logiciels propriétaires à succès dans plusieurs domaines tels que l'Internet, l'industrie et les services financiers. Les logiciels libres permettent de faire des économies financières et d'améliorer la qualité du logiciel. Cependant, leur faible succès auprès des fournisseurs de télécommunications s'explique non seulement par les stratégies d'investissement adoptées antérieurement pour les logiciels propriétaires mais aussi par la perception des risques du logiciel libre.

Plusieurs projets récents, dont la nouvelle génération de système de support opérationnel, l'initiative OpenOss et le projet du logiciel OpenClovis, confirment le potentiel du logiciel libre dans le domaine des télécommunications. C'est Eurescom qui a réalisé l'étude la plus importante de l'utilisation du logiciel libre et de son impact sur les télécommunications. Ce projet analyse le phénomène du logiciel libre du point de vue d'un opérateur de télécommunications. Les résultats de cette étude montrent que le logiciel libre est devenu une très bonne alternative au logiciel traditionnel dans plusieurs domaines, aussi bien au niveau technique qu'économique, et qu'il devrait être inclus dans toutes les stratégies de marché des réseaux d'opérateurs publics. Dans cette étude, le consortium proposait un modèle générique de rôles pour le marché du logiciel libre, où les rôles et les relations sont assignés. Il identifiait aussi plusieurs modèles de marché du logiciel libre particulièrement adéquats dans le domaine des télécommunications.

Un des obstacles les plus importants pour les entreprises de télécommunications utilisant les solutions du logiciel libre est de savoir définir leur position dans la chaîne de valeur des télécommunications et leurs relations avec les parties prenantes. L'objectif de cette thèse est d'aider les entreprises à surmonter cet obstacle. C'est pourquoi elle élargit et instancie le modèle générique de rôles pour le marché du logiciel libre proposé par Eurescom en tenant compte des nouvelles technologies émergentes sur le marché, telles que IPv6, IMS, VoIP et les réseaux *ad hoc*. L'objectif est de faciliter non seulement les relations entre les universités/centres de recherche et les entreprises privées, mais aussi l'exploitation du modèle par de jeunes entreprises technologiques. Le modèle élargi présenté dans cette thèse propose dix rôles et quelques relations entre les utilisateurs du modèle et ses instanciations. De nouveaux rôles ont ainsi été introduits : le consultant en logiciels libres, l'entité responsable du contrôle de la qualité, le fournisseur de formation et le fournisseur de portail.

Le nouveau modèle élargi de rôles pour le marché du logiciel libre est instancié dans trois cas représentatifs et émergents: la solution des communications unifiées, la solution VoIP et les services fondés sur IMS. Nous avons utilisé la méthodologie Osterwalder pour décrire la chaîne de valeur et pour analyser le modèle de marché utilisé dans chaque cas. Cette méthodologie se divise en trois étapes: dans un premier temps, le modèle de marché est décomposé en neuf composantes; dans un deuxième temps, il est évalué grâce à l'analyse F.F.P.M. (forces, faiblesses, possibilités, menaces) et à une série de questions pertinentes; dans un troisième temps, nous essayons d'identifier les possibilités d'innovation et d'amélioration.

Dans le premier cas, nous proposons la création d'une solution de communications unifiées basée sur le logiciel OS et sur les normes ouvertes à l'usage des petites et moyennes entreprises (PME). Cette solution explore le paradigme de l'innovation ouverte pour établir une relation étroite entre les entreprises privées et les universités/centres de R&D. Dans le deuxième cas, nous proposons l'introduction d'un service VoIP et nous suggérons l'utilisation de la plateforme Asterisk. Nous identifions un rôle important que doivent remplir les fournisseurs de formation et les entités responsables du contrôle de la qualité et nous déterminons les chaînes de distribution les plus appropriées pour aborder les marchés internationaux. Finalement, l'approche IMS est utilisée dans le troisième cas pour proposer une solution de convergence mobile-fixe composée d'une vaste gamme d'applications différentes susceptibles de réduire le temps de mise sur le marché des solutions multimédia et de simplifier considérablement le système, en diminuant les dépenses d'équipement (Capex) et les coûts d'exploitation (Opex).

Rezumat

De-a lungul ultimilor zece ani, software-ul cu surse deschise a trecut din mediul specific al investigației și dezvoltării către sectorul întreprinderilor, unde se află în competiție cu software-ul proprietar, care se bucură de succes în diverse domenii, precum Internet, industrie și servicii financiare. Software-ul cu surse deschise poate oferi simultan reducerea costurilor și îmbunătățirea calității software-ului. Cu toate acestea, ascensiunea sa pe lângă actualii furnizori de telecomunicații a fost scăzută, nu numai din cauza investițiilor strategice deja realizate de ei în domeniul software-ului proprietar, cât și datorită percepției riscurilor asociate software-ului cu surse deschise.

Diverse proiecte recente, între care se evidențiază New Generation Operation Support Systems (NGOSS), inițiativa OpenOSS și proiectul de software OpenClovis, confirmă potențialul software-ului cu surse deschise în domeniul telecomunicațiilor. Până în prezent, cel mai important studiu în legătură cu utilizarea și impactul software-ului cu surse deschise în telecomunicații a fost realizat de Eurescom. Studiul a analizat fenomenul software-ului cu surse deschise din perspectiva unui operator în telecomunicații. Rezultatele acestui studiu arată că software-ul cu surse deschise a devenit o foarte bună alternativă a software-ului tradițional, în numeroase domenii, atât din punct de vedere tehnic cât și economic, și că ar trebui să fie inclus în toate strategiile de piață ale operatorilor de rețele publice (PNOs). În acest studiu, concernul a propus un model de afaceri generic, bazat pe software cu surse deschise, având roluri și relații asociate. Astfel, a identificat diverse modele de afaceri adecvate pentru domeniul particular al telecomunicațiilor.

Una dintre cele mai importante hotărâri pentru o companie de telecomunicații, care furnizează soluții cu surse deschise, este să cunoască poziția sa reală în rețeaua de valori a telecomunicațiilor și relațiile adecvate cu toți ceilalți parteneri. Obiectivul acestei teze este să ajute întreprinderile să depășească acest obstacol. În acest sens, teza extinde și instanțiază infrastructura generică de afaceri în software cu surse deschise propusă de Eurescom, ținând cont de noile tehnologii emergente pe piață, precum IPv6, IMS, VoIP și rețele *Ad-hoc*. Obiectivul este nu numai facilitarea relațiilor între universități/centre de cercetare și întreprinderi particulare, precum și exploatarea modelului de către noile întreprinderi tehnologice. Modelul extins, prezentat în această disertație, propune zece roluri și anumite relații între protagoniștii modelului și instanțierile sale. Astfel, au fost introduse noi roluri: consultant de software cu surse deschise, entitate responsabilă cu controlul calității, formatori profesionali și furnizori de portal.

Versiunea lărgită al modelului de afaceri bazat pe software cu surse deschise a fost instanțiat în trei scenarii reprezentative și emergente: soluția pentru comunicațiile unificate, soluția VoIP și servicii bazate pe IMS. A fost folosită metodologia Osterwalder pentru a descrie lanțul de valori și a analiza modelul de piață suportat de fiecare scenariu. Această metodologie constă în trei etape: într-o primă fază, descompune modelul de afaceri în nouă componente; într-o a doua fază, evaluează modelul de afaceri, utilizând analiza SWOT și un chestionar adecvat; în sfârșit, în ultima fază, încearcă să identifice potențialul inovator și căile de perfecționare. În primul scenariu, se propune crearea unei soluții de comunicații unificate,

bazate pe software-ul cu surse deschise și pe normele deschise aflate în uz pe piața întreprinderilor mici și mijlocii (IMM-uri). Soluția propusă explorează paradigma inovației deschise și stabilește o strânsă relație între întreprinderi particulare, pe de o parte, și universități și centre de cercetare, pe de altă parte. Cel de-al doilea scenariu propune introducerea unui serviciu VoIP. Este sugerată folosirea platformei Asterisk, este identificat rolul relevant ce trebuie îndeplinit de către formatorii profesionali, precum și de instituțiile responsabile cu certificarea calității, și cele mai adecvate rețele de distribuție de abordat pe piețele internaționale. În ultimă analiză, cel de-al treilea scenariu folosește abordarea IMS pentru a propune o soluție de convergență mobil-fix, compusă dintr-o vastă gamă de aplicații diferite, care va reduce timpul de punere pe piață a soluțiilor multimedia și va simplifica considerabil sistemul, diminuând cheltuielile de investiție (Capex) și costurile de exploatare (Opex).

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Acronyms

ACD – Automatic Call Distribution

ADSL – Asymmetric Digital Subscriber Line

AN – Ambient Network

ANI – Automatic Number Identification

AP – Access Point

APM – Application Performance Monitoring

ARPU – Average Revenue per Unit or Average Revenue per User

ATM – Asynchronous Transfer Mode

B2B – Business to Business

B2C – Business to Customer

BGP – Border Gateway Protocol

BSS – Business Support Systems

BT – British Telecom

BW – Bandwidth

CAP – Competitive Access Provider

Capex – Capital Expenditure

CDR – Call Detail Report

CEO – Chief Executive Officer

CIO – Chief Information Officer

CLI – Command-Line Interface

CMS – Content Management Solution

COO – Chief Operations Officer

COTS – Custom Off The Shelf

CPA – Content Provider Access

CRM – Customer Relationship Management

CSP – Communications Service Provider

CTI – Computer Telephony Integration

DHCP – Dynamic Host Configuration Protocol

DNIS – Dialed Number Identification Service

DNS – Domain Name System

DMTF – Desktop Management Task Force

DMZ – Demilitarized Zone

DSL – Digital Subscriber Line

EBU – European Broadcast Union

ECS – Electronic Communication Service

ESA – European Space Agency

FAQ – Frequently Asked Questions

FCC – Federal Communications Commission

FMC – Fixed-Mobile Convergence

FMFM – Find Me, Follow Me

FOSS – Free and Open Source Software

FSF – Free Software Foundation

GDP – Gross Domestic Product

GPRS – General Packet Radio Service

GSM – Global System for Mobile communication

GUI – Graphical User Interface

HSO – Hot Spot Operator

IAX – Inter-Asterisk eXchange

ICMP – Internet Control Message Protocol

ICT – Information and Communication Technology

IETF – Internet Engineering Task Force

IM – Instant Messaging

IMS – IP Multimedia Subsystem

IP – Internet Protocol

IPR – Intellectual Property Rights

IPTV – Internet Protocol Television

IPX – Internetworking Packet Exchange

IT – Information Technology

ITU – International Telecommunications Union

IVR – Interactive Voice Response

LAN – Local Area Network

LCR – Least Cost Route

LMS – Learning Management System

LBS – Location Based Service

LDAP – Lightweight Directory Access Protocol

MCU – Multipoint Control Unit

MGCP – Media Gateway Control Protocol

MIME – Multipurpose Internet Mail Extensions

MMS – Multimedia Messaging Service

MNO – Mobile Network Operators

MSAN – Multi Service Access Node

MSP – Managed Service Provider

MTO – Mobile Telecommunications Operator

MTSS – Ministerial Services of Labour and Social Duties

NAT – Network Address Translation

NDP – Neighbour Discovery Protocol

NFAS – Non-Facilities Associated Signaling

NGN – Next Generation Network

NMT – Nordic Mobile Telephone

OOO – Object Oriented Concepts

Opex – Operational Expenditure

OSI – Open Source Initiative

OSPF – Open Shortest Path First

OSS – Operations Support System

PAN – Permanent Account Number

PBX – Private Branch Exchange

PIM – Personal Information Management

PNN – National Numeration Plan

PNO – Public Network Operator

POTS – Plain Old Telephone Service (same as PSTN)

PRN – Partner Relationship Management

PSTN – Public Switched Telephone Network

QoE – Quality of Experience

QoS – Quality of Service

RFID – Radio Frequency Identification

RIP – Routing Information Protocol

RMS – Remote Maintenance Service

SBC – Session Border Controller

SDP – Session Description Protocol

SER – SIP Express Route

SFLC – Software Freedom Law Center

SIP – Session Initiation Protocol

SLA – Service Level Agreement

SMA – Service Monitoring and Alarm

SMB – Small and Medium Business

SME – Small and Medium Enterprise

SMS – Short Message Service

STUN – Simple Traversal of UDP through NAT

TCO – Total Cost of Ownership

TCP – Transmission Control Protocol

TDM – Time Division Multiplexing

TDMoE – Time Division Multiplexing over Ethernet

TMF – Tele-Management Forum

VAR – Value-Added Reseller

VNO – Virtual Network Operator

VoD – Video on Demand

VoIP – Voice over Internet Protocol

VPN – Virtual Private Network

VPS – Virtual Private Server

UDP – User Datagram Protocol

UGC – User-Generated Content

UMTS – Universal Mobile Telecommunications System

Glossary

3G – Third generation of mobile systems. Provide high-speed data transmission and supporting multimedia applications such as full-motion video, video-conferencing and Internet access.

Asymmetric Digital Subscriber Line (ADSL) – A digital technology that allows the use of a copper line with high bandwidths in one direction and a lower bandwidth in the other.

Average Revenue Per User (ARPU) – The amount of money, on average, that a company brings in for each of its customers.

Bluetooth – Wireless standard for short-range radio communications between a variety of devices such as PCs, headsets, printers, mobile phones, and PDAs.

Broadband – A service or connection generally defined as being “always on” and providing a bandwidth greater than 128kbit/s.

Capex Budget – The capital expenditure budget (capex budget) is the cost of developing or providing non-consumable part of the product or system.

Comité Europeene des Postes et Telecommunications (CEPT) – The European telecommunications standardization institution closed down in 1989, and was substituted by ETSI (European Telecommunication Standardization Institute), with headquarters in Cannes, France.

Content Provider (CP) – Business entity that provides content to the end-user.

Churn – Term used to describe the turnover in the number of subscribers to a network, typically measured monthly. There are several different ways of measuring churn (for instance, based on the subscriber base at the start or the end of the month) which means that comparisons between companies or between countries are not always meaningful.

Capability Maturity Model Integration (CMMI) – A process improvement approach that provides organizations with the essential elements of effective processes. It can be used to guide process improvement across a project, a division, or an entire organization. CMMI helps integrate traditionally separate organizational functions, set process improvement goals and priorities, provide guidance for quality processes, and provide a point of reference for appraising current processes.

Coverage – Refers to the range of a mobile cellular network, measured in terms of geographic coverage (the percentage of the territorial area covered by mobile cellular) or population coverage (the percentage of the population within range of a mobile cellular network).

DMZ – In network security field, a DMZ is a network that serves as a buffer between a secure protected internal network and the insecure Internet. A DMZ usually contains servers which provide services to users from the Internet, such as web, ftp, email (SMTP, POP3 and IMAP4), and DNS servers. Although these servers must be open to limited access from the Internet, they should also be protected by a firewall.

ENUM – A protocol that is the result of work of the Internet Engineering Task Force's (IETF). The charter of this working group was to define the Domain Name System (DNS)-based architecture and protocols for mapping a telephone number to a Uniform Resource Identifier (URI), which can be used to contact a resource associated with that number.

Gateway – Any mechanism for providing access to another network. Entrance and exit to a communications network.

Gross Domestic Product (GDP) – One of the several measures of the size of the economy. The GDP of a country is defined as the market value of all final goods and services produced within a country in a given period of time.

Incumbent – The (former) monopoly service and network provider in a particular country.

Internet Protocol (IP) – The packet data protocol used for routing and carriage of messages across the Internet and similar networks.

Internet Protocol Television (IPTV) – Consists in the delivery of real-time streaming TV over broadband IP networks. It is a multicast service delivered to many concurrent users.

Internet Service Provider (ISP) – A company that provides access to the Internet.

IP Centrex – A telephone service in which an IP-based PBX is located in the telephone company's facilities. It connects to the customer via the LAN rather than by telephone wires. IP centrex offers voice over IP and other IP-based services as well as connectivity to the regular telephone system (PSTN).

IP Multimedia Subsystem (IMS) – It is defined by 3GPP/3GPP2 as a new core and service domain that enables the convergence of data, speech and network technology over an IP-based infrastructure.

Integrated Services Digital Networks (ISDN) – A standard developed to cover a range of voice, data, and image services intended to provide end-to-end, simultaneous handling of voice and data on a single link.

Local Area Network (LAN) – A network allowing the interconnection and intercommunication of a group of computers on a single site, primarily for the sharing of resources and exchange of information (e.g., email).

Mobile Virtual Network Operator (MVNO) – A mobile operator that does not own its own spectrum and usually does not have its own network infrastructure. Instead, MVNO's have business arrangements with traditional mobile operators to buy minutes of use for sale to their own customers.

Multimedia Messaging Service (MMS) – An advancing mobile messaging service, adding photos, pictures and audio to text messages.

Opex – Operational expenditure is an on-going cost for running a product, business or system. Opex may also include the cost of workers and facility expenses such as rent and utilities.

Practical Extraction and Reporting Language (PERL) – An interpreted programming language with a huge number of uses, libraries and resources. It is particularly useful for text processing and file conversion, Unix system administration and utilities, web forms, and report generation.

Roaming – A service allowing cellular subscribers to use their handsets on networks of other operators or in other countries.

Return on Investment or Rate of Return (ROI) – The ratio of money gained or lost on an investment relative to the amount of money invested. The amount of money gained or lost may be referred to as interest, profit/loss, gain/loss, or net income/loss. The money invested may be referred to as the asset, capital, principal, or the cost basis of the investment.

Service Level Agreement (SLA) – A legal contract between a service subscriber and a provider or between two or more business partners. An SLA is the basis for the use of any services liable to pay costs.

Telco – Generic term to designate telephone companies.

Total Cost of Ownership (TCO) – The cost required to maintain and support a hardware or software product and/or service. It is used to help consumers and enterprise managers assess both direct and indirect costs and benefits related to the purchase of any IT component.

Unified Communications (UC) – A new technological architecture whereby communication tools are integrated so that businesses and individuals can manage all their communications in one entity instead of separately.

Unified Messaging (UM) – Includes the handling of voice, fax, and regular text messages as objects in a single mailbox that a user can access either with a regular email client or by telephone.

Video on Demand (VoD) – The delivery of video content over broadcast IP networks to the individual viewer initiated by him/her at a time of his/her choice. Most commonly, it is a

streaming unicast service delivered to one user per stream. One variant is the Push VoD, where the video data is partially downloaded before.

Wide Area Network (WAN) – A network allowing the interconnection and intercommunication of a group of computers over a long distance.

WiFi – Local area network that uses high frequency radio signals to transmit and receive data over distances of a few hundred feet. It uses Ethernet protocol and is also referred as WLAN (Wireless LAN).

1 Introduction

1.1 Short Overview

In this chapter we present a brief introduction of the whole dissertation. In a first instance (section 1.2) we analyze the concept of Open Source software, presenting the two different visions about what constitutes Open Source software: one from the *Free Software Foundation* (FSF) and the other from the *Open Source Initiative* (OSI). We conclude this first section by informing that this dissertation will adopt the OSI vision. Later (section 1.3) we explain the context and motivation for the development of this PhD work. Consecutively (section 1.4) we establish the most important objectives of the work. Later (section 1.5) we divulge the most important contributions of this research. Consecutively (section 1.6) we present the papers that were published under the period of this PhD work. At last (section 1.7) we present the outline of the dissertation.

1.2 Definition of Open Source Software

The concept of Open Source software (OSS) is not consensual and there are some different definitions. To clarify this concept, we present here the notion of proprietary software, free software and Open Source software, relatively to the most acceptable definitions.

During the last decades, the majority of software companies have used all the legal means they could to protect the intellectual property of their programs, with the purpose of avoiding the access to the source codes from other competitor companies. This approach can be applied when a company doesn't open the source code of a program, but also when it uses all the intellectual protection mechanisms, such as copyright and software patents. This kind of software is called propriety software.

The difference between proprietary software and free software can be easily explained, because this difference only exists in the commercialization process. When we create proprietary software we assume that we want to get profitability with the product and we have the expectation that the customer will pay to use the product. In the free software, the user doesn't need to pay any money to get and use the product. However, in the most part of cases, the user doesn't get any access to the source code of the product and doesn't have the permission to make any changes in the application.

Generally, the Open Source software refers to a program in which the source code is available to the general public for use and modification from its original design free of charge, in opposite to free software where the access to the source code is usually not allowed. However, there are some nuances in the understanding of what exactly constitutes Open Source software. The *Free Software Foundation* (FSF) and the *Open Source Initiative* (OSI) have different visions about its definition.

The FSF and OSI share the same vision about the main criteria that characterizes an Open Source software. According to them, what is Open Source software depends on the freedom that the users have:

1. To study how the program works and to adapt it to one's personal needs. Access to the source code is a precondition for this;
2. To redistribute copies (as Open Source);
3. To improve the program and release the improvements as Open Source to the public, so that the whole community benefits. Access to the source code is also a precondition for this;
4. To run the program, for any purpose.

Being free in this sense means that nobody should have to ask or pay for permission to redistribute copies, be it with or without modification, in a supported or an unsupported distribution. For this reason, every piece of Open Source software must have a license that guarantees this freedom. It is the definition of this "freedom" that is the subject of debate. With some licenses, redistribution must be under the same license, with full access to the source code, whereas with others, redistribution may take place with only an acknowledgement of the use of the Open Source product.

Another essential condition is the accessibility of the source code. Since this is the most obvious demand resulting from the four criteria the term "Open Source" software is most appropriate. The term "Free Software", which is preferred by the FSF, can easily be misunderstood because of the associations attached to the word "free" as in "free of charge"; this association is unfortunate. Open Source software may or may not be free of charge and it is not the original aim of the Open Source community to distribute software free of charge, although this is a supplementary effect.

In this dissertation, we will mostly use the OSI view and the expression "Open Source software". For its protection, every piece of Open Source software must have a license that guarantees the freedom of use and modification. Its commercial use and how far the protection goes, justifies the existence of several types of licenses.

1.3 Context and Motivation

Currently, the telecommunications industry is facing several changes:

- Telecom service providers are looking to reduce their costs using commodity software and commercial off-the-shelf (COTS) hardware building blocks;
- Telecom service providers require seamless integration of COTS carrier grade components. The integrated solution must be validated for carrier grade availability;
- The growth of packet traffic is putting pressure on communications networks originally designed for "store and forward". Platforms in an all Internet Protocol (IP)

environment that maintain carrier-class characteristics are delivering increasing levels of availability and dependability;

- Operators want to decrease time to market and increase the capability for fast delivery of new services by shortening the development time and unifying platforms;
- Operators want to roll out the above capabilities while still making money and increasing profits.

The rapid pace of technological development in telecommunications is based on a stream of innovations, many of which are radical. Numerous radical technological innovations introduced during the past decade have created new telecommunications systems, services and/or radically modernized old ones, such as the telephone network. Following current technological innovation theories, radical innovations may inaugurate the emergence of new technological paradigms, initiating developmental patterns variously termed as “technological trajectories”.

The business market has always been a catalyst for change and innovation in telecommunications and today we see the same pattern emerging in the enterprise data market. The data enterprise market, with its low regulatory hurdles and high density and value per user, has proved a fertile ground for the incubation of disruptive business models. Technologies have been able to improve mostly unencumbered by the regulatory and technological barriers that exist in the residential market. To date, traditional service providers have remained largely insulated from these disruptions, instead benefiting from them, as the rise in networking has led to increased demand for bandwidth and connectivity. The emergence and rapid improvement of Voice over IP (VoIP) technologies provide companies with a reliable way to translate voice traffic into data packets and route them over existing IP private data networks, enabling new functionality and eliminating the need to pay access tolls. For incumbent service providers, IP-based networking creates both threats and opportunities that cannot be ignored.

At the same time, when we look to the Open Source software, we realize that in recent years the expansion, development and improvement of Open Source software have been taking place at such a rate that it is a widely accepted fact that the Open Source paradigm is completely changing the rules by which the software industry operates. However, the penetration in telecommunications industry is almost residual, with practically no incumbent telecommunications companies deploying this type of software. The niche Open Source components and solutions available do not cover all technical and non-technical requirements of telecom enterprises, but they are already definitely assisting the majority of SMEs requirements, and do so at a low cost. For this reason, telecommunications companies with an interest in offering services to the SME market should encourage the use and creation of new components and solutions based in Open Source platforms.

1.4 Objectives

In this dissertation we intend to help Small and Medium Businesses (SMBs) and spin-off companies that operate in the telecommunications field to establish their correct positioning in the telecommunications value chain and to create value with the use of Open Source software in the development of their products.

We expect to make an important contribution for companies operating in telecommunications with the following two roles:

- Open Source System Integrator – companies that use Open Source software in order to build Open Source based system solutions composed by a wide range of new emergent technologies, such as unified communications, VoIP and IMS services. Apart from Open Source services, also proprietary services can be implemented upon Open Source systems;
- Open Source Service Providers – companies that sell services for Open Source products. Open Source support services encompass Open Source product related failure handling, adding of new features to the Open Source product, versioning, and others.

We also intend to create business models that take into account the major benefits of Open Source software to provide reliable solutions in terms of quality, development time and integration. We intend to bring these important qualities to the consumer market and facilitate the integration of commercial and Open Source components. Besides that, the business model shall facilitate the relationships between universities, research centers and private companies. With this close relationship we intend to reduce the time to market of the solutions developed in partnership by both entities. These business models will be validated in the telecom market and we expect to receive important feedback from some start-up companies that emerge in the segment of Open Source solutions.

1.5 Major Contributions

The main contributions of the research work spread over the adoption of Open Source software in the telecommunications industry. In this thesis we have:

1. Characterized the telecommunications industry, its major changes and innovation regimes. We also analyzed a wide range of Open Source business models that a company can adopt to succeed in the market using only Open Source components or mixed Open Source and proprietary tools, and the impact of the appearance of new technologies in the telecommunications market;
2. Analyzed seven telecommunications companies that adopted Open Source software in their products. We extracted common successful approaches and presented their strategy and positioning in the telecom value chain;
3. Extended the generic Open Source business roles model initially proposed by Eurescom. The Open Source Consultant, Quality Certification Entity, Training

Provider and Portal Provider roles were introduced in this dissertation. These new entities were proposed to improve the overall quality of Open Source solutions, to facilitate the adoption of Open Source solutions by the telecommunications market, to easily integrate typical web and telecom content and to facilitate the integration of Open Source and proprietary solutions. All these entities can be performed by a technologic start-up company with strong central competences in these fields;

4. Instantiated the open source business roles model to three different scenarios. The first scenario suggests the creation of a unified communications solution based on Open Source software and open standards; the second scenario proposes the introduction of a VoIP solutions; and the third scenario uses the IMS approach to deliver a converged fixed-mobile solution. For each scenario, the main components of its business model are described, the business model is assessed and the potential innovation and improvement paths are identified. This allows SMBs companies that intend to use and focus their attention in OS solutions, to easier define their strategy, positioning and relationship with other stakeholders.

1.6 Published Papers

Under this PhD research project, until the end of April of 2009, the following papers were published:

- “PolySpeak: An Asterisk-based approach” accepted at the International Conference on Signal Processing and Multimedia Applications (SIGMAP 2008). This paper presents the PolySpeak solution developed at Faculty of Engineering of University of Porto (FEUP). It shows the major functionalities and benefits of this solution and demonstrates how the Asterisk can be easily configured and adapted to the specific requirements of an university institution;
- “Creating value with Open Source software” presented at the International Conference on Business Sustainability (BS 08). This paper analyzes how the Open Source creation process is quickly becoming a threat and also an opportunity to businesses of all kinds. The paper presents six successful Open Source business models and explains how these business models can be embraced by willing software companies;
- “An Open Source business roles model for IMS-based converged services” submitted and published at APRITEL Competition for the Development of Telecom Sector (PLUG 08). This paper proposes a business roles model for the introduction of IMS-based services. The proposed framework gets the major benefits of Open Source software, facilitates the integration of commercial and Open Source components in a whole reliable solution and reduces the time to market of new solutions;
- “The impact of Open Source software in IP telephony” presented at the Iberian-American Conference on Internet (CIAWI 2008). This paper presents the Asterisk solution and its impact in the VoIP business market. Besides that, it shows the major challenges that the Asterisk solution still faces in the market;

- “New revenue streams with IMS and Mobile Web 2.0” presented at the 2nd International Conference on Computer Science & Global Telecommunication Technology (CSGCT 2009). This paper analyzes the potentiality of confluence of telecommunications with Web 2.0. It also compares two implementation approaches of an IMS/Mobile Web 2.0 strategy and looks to the new business models generated by the combination of these two technologies;
- “Open innovation in SMEs that create value with Open Source software” presented at the 29th International Conference on Entrepreneurship and Innovation (PODIM 09). This paper analyzes the recent phenomenon of Open Source software as part of corporate open innovation. Firstly, it reveals the major reasons and barriers for the adoption of open innovation in SMEs; then, it presents the major pro- and anti-innovative features of OSS;
- “Mitigating the security risks of unified communication” presented at the International Conference on Engineering and Applications (ICTTA 2009). This paper presents the most common risks faced by the major dominant technologies used in unified communications solutions and an approach to mitigate them;
- “Risks of migration to IMS and a way to their mitigation” presented at the 7th Conference on Telecommunications (ConfTele 2009). This paper proposes the use of a Service Delivery Platform (SDP) to reduce OPEX and CAPEX expenditures for operators and decrease the risks of their customers churning on a IMS migration approach;
- “Creation of value with Open Source software in the telecommunication field” presented at the II International Interdisciplinary Technical Conference of Young Scientists (InterTech 2009). This paper proposes a new extended version of open source business roles model and evaluates the proposed framework for three pertinent and emergent scenarios, respectively: unified communications, VoIP solution and IMS-based services;
- “A proposed unified communications platform based on Open Source technologies” presented at the 4th Iberian Conference of System and Information Systems (CISTI 2009). This paper proposes a layered architecture for a UC solution based on Open Source technologies and open standards;
- “Unified communications: different approaches for different types of enterprises” presented at the IADIS Multi Conference on Computer Science and Information Systems (MCCSIS 2009). This paper studies with detail the large enterprises and SMEs approach for the implementation of a unified communications solution;
- “Paths to change and improve business models” submitted to the Business Horizons Journal. This paper suggests nine ways to change the actual business models of companies to attend new business opportunities and increase their flexibility to market changes;

- “Paths to accomplish a successful open innovation 2.0 strategy” submitted to the International Journal of Innovation Science. This paper presents seven guidelines that should be included in an open innovation 2.0 strategy.

1.7 Structure of the Dissertation

Chapter 1 gives a brief introduction of the whole dissertation and establishes the concept of Open Source adopted in this dissertation. Besides that, it reveals the motivation and objectives of the work, its major contributions and published papers, and its structure.

Chapter 2 looks to the structural analysis of the telecommunications sector, which includes a concise industry overview and business trends, a brief look of mobile Internet market, an analysis of the intensity of competition in the telecommunications sector and a forecast of the most common global competitive strategies followed by telecom operators.

Chapter 3 reviews the business models adopted by telecommunications companies. This third chapter takes a brief overview about the classical business models, proves the breakdown of current models and presents the new challenges to telecom operators and suppliers. After that, it briefly presents the major new emerging value chains and roles in the telecom industry that includes the 3GPP IP Multimedia System (IMS), the mobile broadcast convergence and the ambient networks.

Chapter 4 looks to the innovation process in the telecommunications field. This chapter characterizes the innovation process, studies the impact of radical innovations in the telecom industry, and demonstrates how established telecommunications equipment and system providers have been challenged by competition arriving from data networking and Information Technology (IT). The chapter also studies the impact of Open Source software in the telecommunications market, the most important Open Source business models and some of the initiatives that intend to promote the Open Source software in this technologic field.

Chapter 5 looks to the new emergent technologies in the telecommunications field. These technologies create new challenges for existing companies and will create new opportunities for the appearance of new players in the market. The technologies that are reviewed in this chapter include the IPv6 protocol, the IMS architecture, the VoIP technology and ad-hoc networks.

Chapter 6 presents and analyzes some case studies of telecommunications companies that are already in the market and use Open Source software in the development of their products, namely employing Asterisk and SIP platforms. The following six companies were analyzed: Netcall, VipVoz, NextStag, Bicom Systems, Critical Links and iPortalMais. Besides that, we analyzed one project VoIP@FEUP/PolySpeak that was developed by Faculty of Engineering of Porto and is commercially explored by Suprides company.

Chapter 7 proposes a framework for the creation of value with Open Source software that a telecom company can follow to develop and sustain its business. This framework takes into

account the recent technologies in the field of telecommunications and points out the advantages of knowledge transfer as a competitive edge and establishes the importance of a close co-operation between private companies, public entities and research centres. In a first instance, it presents the methodology approach, a possible positioning for a company that operates in the telecom field, and concretizes this positioning by presenting three scenarios for the application of the framework.

Chapter 8 summarizes the major findings of this work and the contribution to knowledge made in this dissertation. Moreover, it raises new questions which would benefit from being investigated in further research.

Finally, the following annexes can be found at the end of this dissertation: *Annex A* divulges the major worldwide telecommunications regulation entities; *Annex B* shows the most popular Open Source licenses; *Annex C* illustrates the developers' motivation of Open Source software; *Annex D* presents the most typical arguments against copyleft and proprietary license models; *Annex E* analyzes the total cost of ownership of OS solutions; *Annex F and G* describes the most important features of Asterisk and SIP platforms; *Annex H to N* contains the documents provided by companies and interviews conducted in each case study; *Annex O* describes the role of the Software Freedom Law Center; *Annex P* presents the most important conclusions of the study conducted by ThinkStrategies.com to evaluate the use of IT managed services; *Annex Q* divulges the major Open Source VoIP applications available in the market; finally, *Annex R* contains the validation interviews conducted to evaluate some results of the dissertation.

2 Structural Analysis of Telecommunications Sector

2.1 Short Overview

In this chapter we make a structural analysis of telecommunications sector. In a first instance (section 2.2) we take a brief look about the industry of telecommunications in terms of evolution, markets dimensions and revenues. Consecutively (section 2.3) we explore the current trends of the telecommunications market and operators strategies. Subsequently (section 2.4) we take a brief look about the new concepts of mobile Internet market and ambient mobile communications. Later (section 2.5) we analyze the intensity of competition and regulation and the market share of the main European mobile networks. At last (section 2.6) we study the most common global competitive strategies that a telecom operator can follow.

2.2 Industry Overview

The world of telecommunications has changed immensely in the last decades of the last century and is continuing to change in this new century. The last 30 years has seen huge technological and commercial developments in the field of telecommunications. There have been whole new multibillion industries created by the rise of the Internet and mobile communications which have contributed significantly to the national economies of industrialized countries.

The British telecom regulator *Ofcom* estimates that about 4% of the United Kingdom (UK) GDP is derived from the telecommunications industry and the largest companies in many national economies are telecoms operators like *NTT* in Japan and *PT* in Portugal (Montgomery, 2005).

Comparing to the big amount of shifts that have occurred on the mobile and data communications networks, it may be thought that the traditional fixed line voice networks have not changed much during these years, this would be incorrect. There have been in the last years, and still are, underway substantial shifts in the underlining building blocks of the fixed line networks – the central office exchange or voice switch which are laying the foundation for a new generation of voice, data and multimedia services.

In this point, it is important to contextualise the recent changes by reviewing what has happened in the telecommunications industry before the advent of the actual *infocommunications* industries.

A good model for comparing the evolution of the telecommunications industry was produced by Fransman (Fransman, 2000). In his view the three stages of the development of the industry are:

- The old telecoms industry (to the mid-1980s);
- The transition telecoms industry;

- The birth of the infocommunications industry.

The Old Telecoms Industry (to the mid-1980s)

The old telecoms industry was the time when the sector was considered to be a natural monopoly and that due to increasing returns to scale telecoms services could only be provided by a monopoly network provider. Telecoms in most industrialized countries were provided by one monopoly network operator.

In most large countries the network operator would purchase most of its network equipment from one main telephone equipment maker like *Deutsche Telecom* with *Siemens* in Germany, *France Telecom* with *Alcatel* in France and *Bell* with *Western Electric* in the United States (US).

In the smaller industrialized countries (Sweden with *Ericsson* being a notable exception) and in most of the developing countries, the national monopoly telecoms carriers procured their telecoms equipment from the handful of specialist telecom equipment makers who competed in world markets. While being profitably locked into long-term relationships with the monopoly network operators in their home country, these specialist technology suppliers competed vigorously in the rest of the world where telecoms equipments markets were not similarly locked up by competing suppliers with privileged supply relationships with the national operator.

The Transition Telecoms Industry

In the mid-1980s, for different political-economic reasons, Japan, the UK and the US decided to the end of the monopolies of their national monopoly networks operators. The result was the birth of competition in the fixed networks. At the same time the first mobile technology was being tentatively developed with the *Nordic Service* in Scandinavia.

Although liberalising regulatory regimes provided a necessary condition for rapid and successful entry by the original new entrants, they were not sufficient. Equally important were low technological barriers to entry into the telecoms services markets created by the existence of specialist telecoms equipment suppliers.

These specialist equipment suppliers provided the “black-boxed” technologies that the new entrants needed to construct and run their own networks. Unlike their counterparts in other industries such as pharmaceuticals or semiconductors, where substantial in-house technological capabilities were necessary in order to enter and compete, the Original New Entrants in the Telecoms Industry were able to turn to specialist technology suppliers for most of their technology requirements. Without the knowledge-acquisition and learning process that the specialist technology suppliers underwent in the old telecoms industry, new entrants would face formidable technological barriers.

Fransman considers that from the point of view of the specialist technology suppliers, liberalisation created new markets for their accumulated knowledge and competencies. The same author affirms that it is important not to confuse Research and Development (R&D) with innovation. Firms with low R&D intensity may nevertheless be highly innovative, and their innovativeness may lead to competitiveness and high profitability. One example of this was the *TMN MIMO* prepayment service that was invented by *TMN*, a Portuguese mobile

operator allowing *TMN* to regain market control in the Portuguese mobile telephony market (Montgomery, 2005).

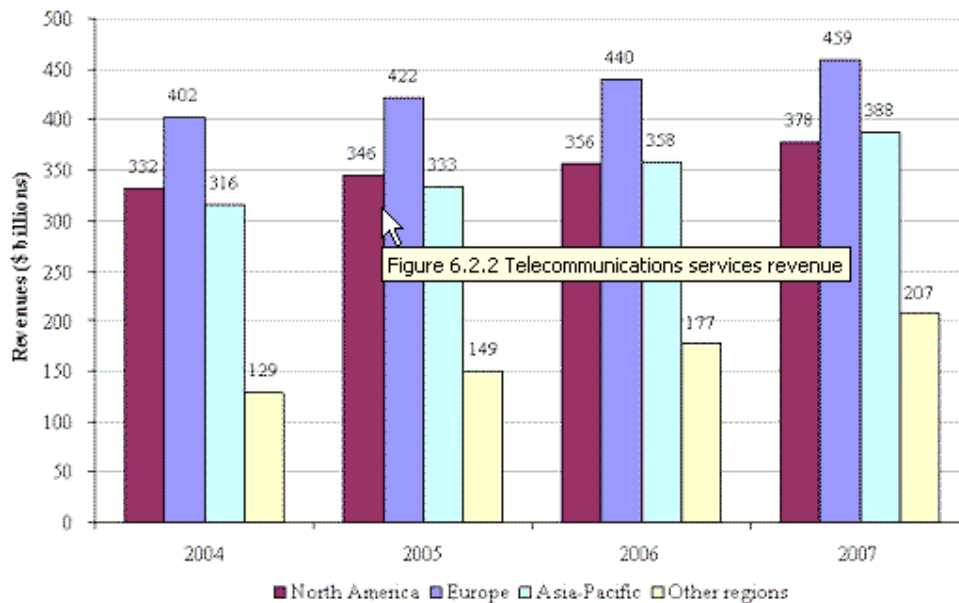
The Infocommunications Industry

In the early 1990s the Internet emerged as a commercial force, creating an alternative way of delivering the same or similar services to those provided over the conventional circuit-switched telecoms networks and, in addition, a host of new services. But the Internet was far more than just an alternative platform; it was nothing less than a radically new paradigm in the area of both information and communications, changing fundamentally the way people would think of problems and solutions in the field. Furthermore, by inserting itself into the very fabric of the Telecoms Industry, the Internet brought about the metamorphosis of this industry into what will be termed by Fransman the *Infocommunications* Industry.

In today's uncertain telecoms market, voice services have been a steady and predictable revenue source. In 2005, the global voice market was estimated to be worth approximately \$1,7 trillion, with industry projections of single-digit percentage growth over the next five years (Verizon, 2005).

In the figure 1 we show the global voice telecommunications from 2004 to 2007.

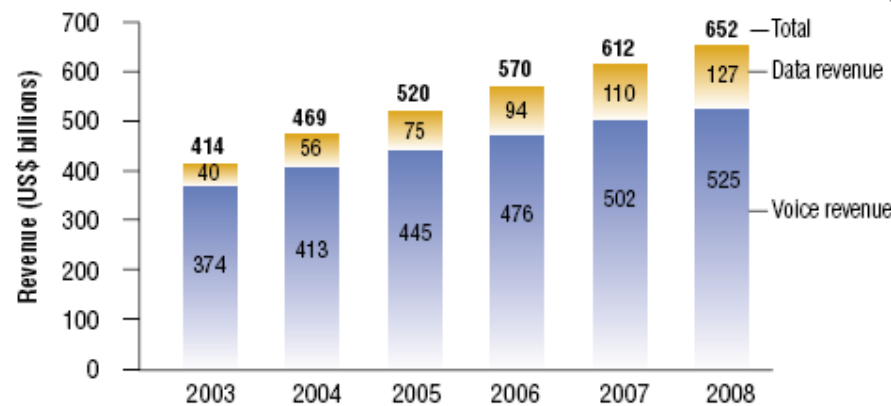
Figure 1: Global voice telecommunications revenues 2004 - 2007



Source: IDate Digiworld Yearbook, 2008

Today's telecommunications industry includes a wide range of technologies, delivering varying combinations of bandwidth and mobility. Telecom operators are pursuing growth along multiple paths – voice, data and integrated combinations of both.

Throughout the coming decade, Mobile Network Operators (MNO) will still depend on voice services for a majority of their revenue. Looking to the figure 2 we can confirm this situation.

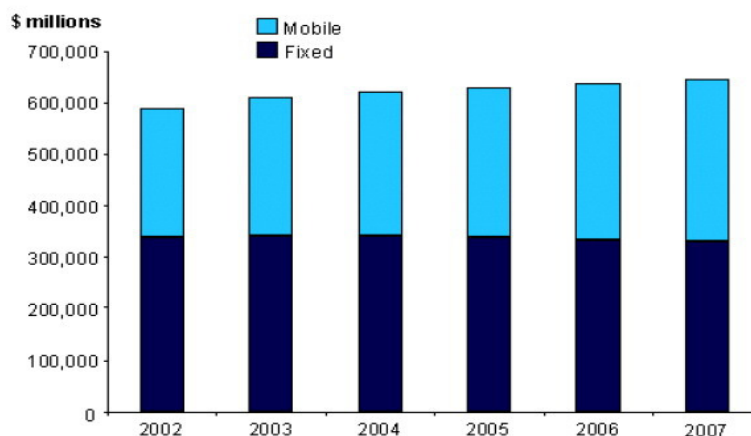
Figure 2: Voice and data revenue

Source: Orum Research, 2005

However, the voice market in most developed countries is mature and displaying all the signs of stagnation:

- Voice growth in all regions has clearly slowed – In Europe, *France Telecom* posted just 2% growth in 2002/2003. In Asia, *NTT* reported a drop of 4% in its revenues for the year ending 31 March 2003 and in North America *Bellsouth* announced a 7% drop revenues in 2002;
- Voice profitability has levelled off – *Telstra* in Australia reported 10% net income margins in the half year ending December 2002, compared with 14% for the same period of the previous year;
- Operators have recognised and taken onboard the need to innovate – Incumbent carriers are adopting a strategy of defending the core of voice revenues while seeking to add new non-voice revenues. In Asia broadband and WiFi services are looked toward to provide sources of incremental growth;
- A considerable number of operators have taken steps to simplify their business – a return to core business by some operators has seen them reverting to a tighter market scope. *Telstra*, for example, has retreated from many of its overseas investments and dot-com ventures;
- The emphasis among both incumbent and competitive operators has shifted from growth to gaining market share – Many former incumbents talk about how they have stopped share erosion and many competitive operators are seeking to grab market share either from each other or from the incumbent;
- Competition is becoming fiercer – Many new operators were attracted into the market when it was growing. With the market slowdown, many have now retreated or gone out business.

Figure 3 shows that global voice revenues in developed market growth at around 2% per year over the period 2002 to 2007, in line with GDP growth. However, within this total, fixed voice revenues declined after 2003.

Figure 3: Voice revenues in developed markets

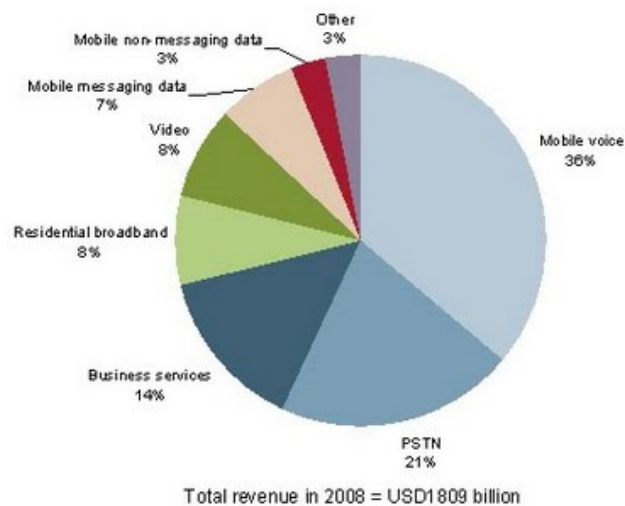
Source: Verizon, 2005

Attending to the figure 3, overall fixed voice revenues are forecast declined at around 0,5% per year until 2007. Mobile voice revenues on the other hand grew a rate of around 4,5% per year until 2007, by which time mobile voice will account for 49% of total voice revenues in developed markets.

The growth rates for voice revenues in developed markets are modest when compared to developing markets, where total voice revenues are expected to grow by 8,7% per year. By 2007, mobile voice revenues in developing markets accounts for 53% of total voice revenues.

We can also analyze the number of mobile subscribers (figure 4). Global telecom services revenue now is lead by mobile services at 46 percent of total revenue. On the other side, wired voice revenues now account for 21 percent of total revenues; business services account for 14 percent of revenue; and consumer broadband and video represents about eight percent of total.

In fact, mobile phones overtook fixed lines in 2002 on a global scale, when the strategic importance of mobile phones had become clear not only in the developed world, but also in the developing world. This situation happened because typically consumers have relatively constant budgets for voice, and so fixed voice volumes basically reflect the unaffordability of mobile voice. During this time, mobile operations have been to translate stable demand into an affordable proposition. Therefore, once mobile can meet demand affordably, any kind of competitive pricing for voice and fixed or broadband is largely irrelevant.

Figure 4: Mobile subscribers and fixed lines

Source: ITU World Information Society Report, 2009

Substitute and competitive services to voice are having an on-going impact in slowing the growth of voice revenues:

- SMS generated an estimated \$36 billion of revenues worldwide in 2002. The substitution effect of SMS on both fixed and mobile voice is real. SMS and voice compete for the consumers time and communications budget. According to *Jupiter Research* "In the space of just a few years, mobile messaging has become an immense global industry generating over \$55 billion in 2005, the largest portion of this revenue comes from simple SMS (estimated \$35 billion in 2005)";
- E-mail has substituted some voice calls, but so far this substitution has occurred mostly among businesses rather than consumers;
- Instant Messaging (such as MSN Messenger and Yahoo Messenger) is much more immediate and interactive compared to e-mail. Instant messaging has a substituting effect on voice, and this effect is set to continue;
- PC voice applications are set to become universally available at PC users. IP originated voice services are also becoming available to consumers and, although it is generally held that the market impact of PC/IP voice will be marginal in developed countries (until quality, cost and convenience issues are addressed), it is yet another substitute service to legacy voice access and traffic carriage.

This last technology deserves a special analysis and attention. The Voice over IP (VoIP) is one of the hottest developments in telecoms today, and is gaining credibility in both the business and residential markets. This brings great opportunities for many players in the market, including telcos, cable operators and ISPs. But the arrival of VoIP also poses a threat to established operators, and will have a negative impact in their revenues (Dawson, 2004).

By nature, IP is flexible, and has enabled the development of a wide variety of innovative telephony solutions that are gaining acceptance among businesses. It is now possible for

businesses to have the richness of a PBX feature set without paying PBX prices. Legacy vendors have introduced less costly IP PBX systems to help their installed base migrate to IP, as well as bring PBX functionality to a new set of customers they could not previously reach with a TDM-based PBX. Similarly, service providers are now offering IP Centrex as a way for traditional Centrex customers to get more for less. Carriers are also offering IP Centrex on a hosted basis to smaller businesses that could not justify a full PBX system.

The enterprise PBX market is substantial, especially in terms of the revenue opportunity for PBX vendors. However, there is another substantial portion of the business telephony market that does not use PBX systems. For these businesses the capital investment is not justified, and less expensive TDM-based systems can provide the functionality they need. IP-based alternatives exist for this market, but both vendors and carriers have yet to develop strong channels to educate and support these businesses with IP. These conditions set the stage for Open Source telephony. Over the past years, Open Source software has gained considerable acceptance throughout the enterprise environment and more recently has been applied to telephony. The inherent appeal of Open Source is lower cost, and with the advent of PC-based PBX solutions, the addressable market opportunity is substantial.

Open Source telephony is largely software-based, and is by nature less costly than hardware-based PBX systems. Aside from cost, however, there are several other factors that make Open Source attractive for business telephony. These are summarized below:

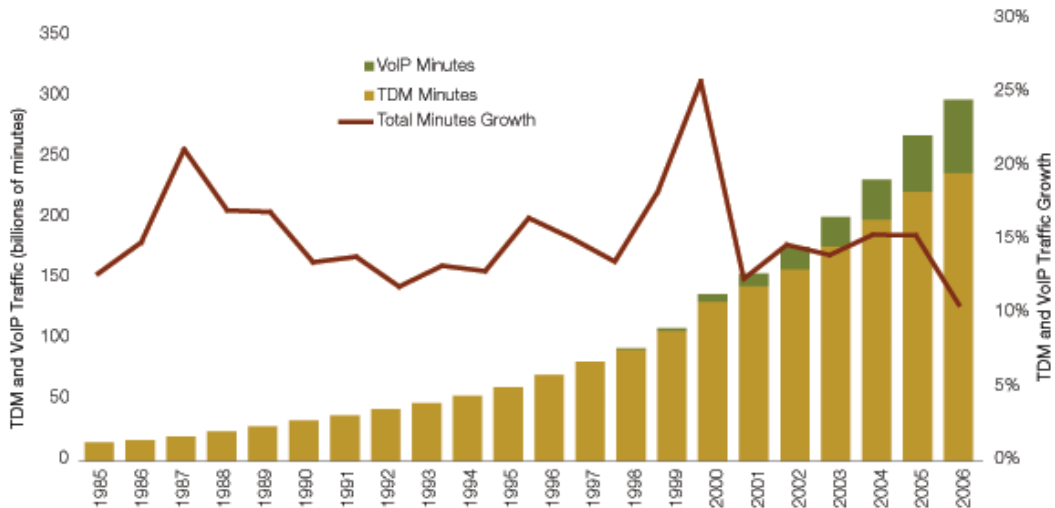
- Lower costs – larger businesses can replicate their TDM PBX features at a fraction of the cost, while smaller businesses can have the same look and feel as larger businesses at a price they can afford;
- PBX-type feature set – by their nature, Open Source PBX solutions include features added as required by users worldwide. The feature set is much richer than any closed system;
- Flexibility – Open Source PBX solutions can adapt and integrate with almost any existing telecom infrastructure, whether it be directories, dial plans, billing, etc;
- Open system – end users can customize almost any aspect of their telephony software. This allows them to add features or modify existing features where and when they like. Open Source puts control in the hands of the customer;
- Scalability – Open Source telephony system can be easily and economically expanded. No costly network hardware upgrades are required.

The consumer VoIP has also the greatest current potential to disrupt the market of any form of VoIP. As it begins to gain ground among residential users, it will take voice market share from established players, force down prices and eventually drive some customers to abandon their PSTN lines altogether.

After ten years of development, Voice over Internet Protocol (VoIP), the ability to transmit voice calls over the Internet and IP-based data networks, is finally a grown-up technology. The promise of lower costs and greater functionality and flexibility than conventional fixed lines positions VoIP as potentially the future of voice telephony.

In the figure 5 we can analyze the evolution of voice traffic over PSTN and VoIP technologies.

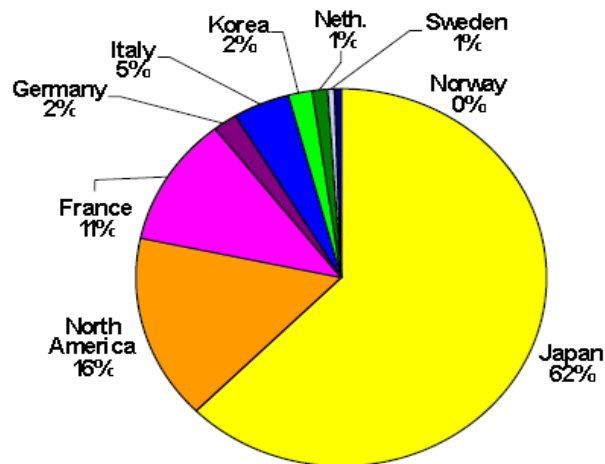
Figure 5: International voice traffic (billion of mins)



Source: ITU in TeleEvo Conference, 2006

However, VoIP is still a marginal service in most countries at present, like we can check in the figure 6, but it will become increasingly prevalent over the next couple of years. Japan is the oft-cited example in this context, but it is unique and revenue erosion on the same scale will not occur elsewhere.

Figure 6: Distribution of VoIP subscribers (mid-2005)



Source: ITU in TeleEvo Conference, 2006

In general, it's widely admitted that VoIP provides important economic benefits over the traditional telecommunications networks, namely:

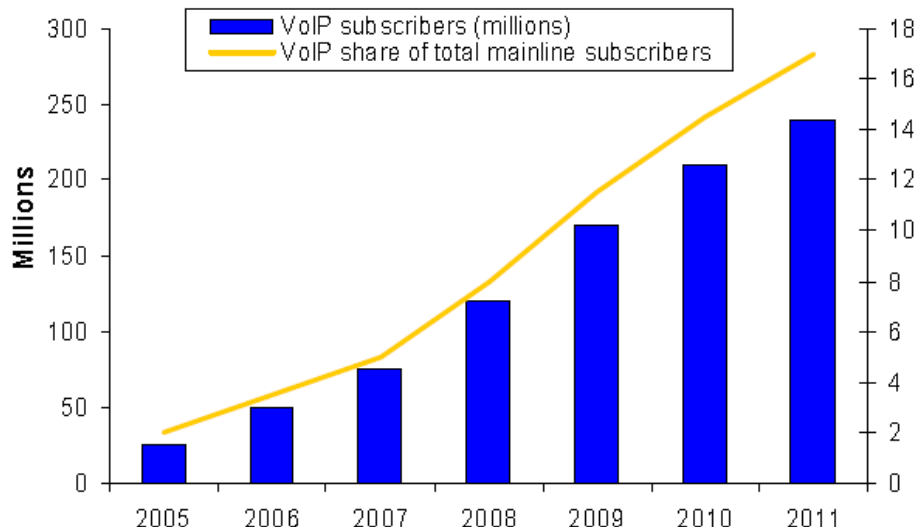
- Greater efficiency – the conventional circuit-switched technology of the PSTN requires a circuit between the telephone company's switch and the customer's premise to be

open and occupied for the entire duration of a call, regardless of the amount of information transmitted. In contrast, on IP networks, whether voice, text, video, computer programs, or numerous others forms of information, travels through the network in packets that are directed to their destination by diverse routes, sharing the same facilities most efficiently;

- Lower cost – IP systems will offer a more economical means for providing communication connections. Also, and this is one of the sources of concern on the part of incumbent voice long distance carriers, Internet technology makes available to anyone with a personal computer and modem the ability to bypass the long distance PSTN;
- Higher reliability – in some respects, IP networks also offer the potential for higher reliability than the circuit-switched network, because IP networks automatically re-route packets around problems such as malfunctioning routers or damaged lines. Peter Hall, Ovum's research director of IP services, considers that "In terms of overall business continuity, VoIP could prove to be even more resilient than legacy PBXs because with IP, you can distribute processing across a number of sites, and thus be more resilient to failures" (Hall, 2004);
- Supporting innovation – IP is a non-proprietary standard agreed on by hardware and software developers, and is free to be used by anyone. This open architecture allows entrepreneurial firms to develop new hardware and software that can seamlessly fit into the network. In contrast, the circuit switched network operates are a closed system, thus making it more difficult for innovative developers to build and implement new applications.

VoIP investments ultimately should not be judged on cost savings only. Bringing voice and video applications together onto a PC desktop unleashes an array of new capabilities that can radically improve communication amongst employees. For the last century, telephone technology has largely been proprietary. Now, the introduction of open standards promises something new: the innovation. In short, the plain old telephone is set for advanced applications and interoperability with desktop and other applications in ways that before were, if not impossible, tremendously expensive and cumbersome.

AT&T predicts that the use of VoIP may mirror the lessons of e-mail and mobile telephones over the last ten years and it will have a strong growth in the next years (AT&T, 2004). *IDATE* estimated that the total revenue from VoIP raised 100 million by 2008 and predicts that the number of VoIP worldwide subscribers will rise over 220 million by 2011 (figure 7).

Figure 7: Worldwide VoIP subscribers

Source:IDATE, 2006

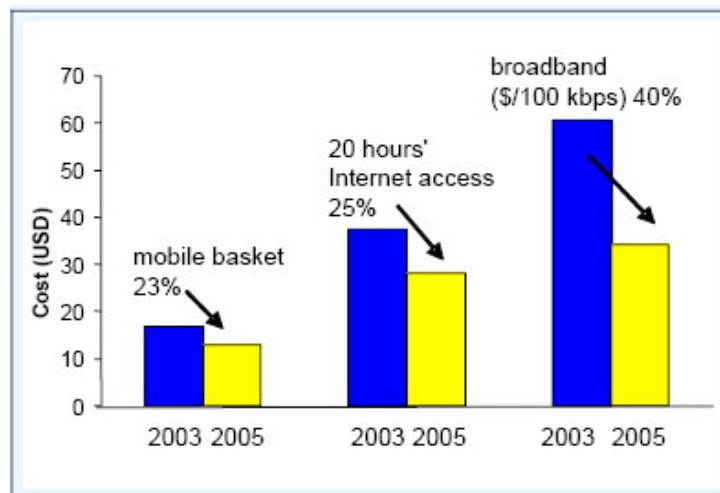
Another study conducted by *Ovum* anticipates that traditional PSTN providers in some of the countries with the highest VoIP take-up (such as Japan, the US and Canada) will lose 3% of their voice traffic per year for the next several years. In countries with lower take-up rates, such as most of Western Europe and some Asian countries, the loss is already 10-15% by 2008. In countries with lower broadband penetration, and therefore less potential for VoIP uptake, the impact will be less (Ovum, 2004).

Meanwhile, VoIP uptake will drive down PSTN voice prices making the impact greater than simply PSTN traffic lost to VoIP. Prices will come down on average by 5% per year, largely driven by competition from subscribers VoIP providers offering low-price and flat-rate packages. Many operators will therefore begin to lose revenues at a rate of 5-10% when VoIP begins to seriously kick in, while others will suffer losses at around 3-5% per year (Ovum, 2004).

2.3 Business Trends

In the short term, the fierce competition among voice providers is set to continue as market share growth/maintenance becomes the dominant focus in a low grow market. This should lead to innovative and targeted tariffing strategies. However, in the long term, players will have to rein in their aggressive pricing strategies in favour of more subtle competitive behaviour in an attempt to preserve already thin margins (Falshaw, 2005).

The costs of mobile, Internet and broadband have been decreasing lately as we show in the figure 8: the analysis is based on change over time in a series of monthly baskets. For broadband, the price is based on the price per 100kbit/s of always-on service per month (in this context, broadband means speeds greater than 256 kbit/s).

Figure 8: Cost of mobile, Internet and broadband

Source: ITU World Information Society Report, 2006

Some players will go out of business and others will merge or be acquired, reducing the number of players and thus the amount of choice available. But choices may also be more complex as individuals resort to “confusion marketing”. Mobile-style pricing involving multi-tiered discount plans and monthly fixed price packaging is likely to be introduced into the fixed market, promising savings but making direct comparisons between packages more difficult. An increasing array of bundled packages will also become available, allowing users to choose all their services from a single provider for a single monthly price.

Incumbent, along with other leading players, will focus aggressively on cost reduction in order to maintain margins while revenue growth is difficult. They will also take advantage of superior volume and scale to achieve a cost leadership position. Whereas, in the past, they have been complacent about defending their customer base, they will now fight more aggressively to maintain market share and retain high value customers.

For competitive providers, niche rather than a “me too” strategy is likely to be more successful. They should look, therefore, for the markets that incumbents find difficult to deal with (for example, SMEs) and develop total service offering to support them well. In a low-growth (or non-growth) market, they can only grow by taking market share and so will need to differentiate to succeed, preferably not on price, since the incumbents are likely to achieve a lower cost bases in the long term. They can successfully take advantage of their smaller size to out manoeuvre larger operators, “cherry-picking” the most attractive opportunities than seeking to provide blanket coverage at universal prices (Falshaw, 2005).

For suppliers to the voice services industry, the mantra must be “know the business of your customer”. In a low growth market, new sales into operators will need to be justified under the banner of increased efficiency or cost reduction rather than simply increasing revenue.

Capex budgets have been dramatically reduced in the last two years and are unlikely to rise quickly in the short term, especially while the focus for many providers is on cash generation. However, high-growth areas such as broadband will still drive significant demand for equipment in selected sectors.

Fixed operators can do a lot to reduce the speed at which users substitute fixed with mobile communications. Fixed operators must emulate the successful strategies of the mobile operators (such as the inclusive minute plans) but also play on their strengths, such as their closer relationship with their customers. In addition, they must look at what mobile operators cannot do (or cannot do well), and pursue these areas – for example, exploiting links with broadband and content providers.

Overall, fixed operators must establish, build, strengthen and maintain customer relationships by leveraging account management and billing customer contacts. Mobile operators cannot do this effectively with their prepaid customer base – and prepaid is the fastest growth area of the total mobile customer base in many countries.

A move towards subscription-based tariffs with bundled minutes included is a better defensive strategy. However, caution must be exercised. Increasingly, fixed and mobile users are complaining about the range and complexity of the tariffs in the market, which prevents them from making informed choices. Operators must simplify their tariffs. Flat-rate tariffs or bundled minutes help users control their telecoms costs more effectively. Research has shown that users are happy to budget at higher levels, providing there are no hidden surprises. Fixed operators have to shape their subscription packages to suit their market position, customer base and cost structure. Doing nothing and charging by the minute is a recipe to failing revenues.

Fixed operators must use to their advantage the growing importance their subscribers place on calling mobile phones. They should develop tariff plans that include bundles of calls to mobiles. Fixed operators should pass mobile termination charge declines onto users, because their competitors will do so. Fixed operators could also exploit their cost advantage compared to mobile off-net calling to stimulate growth in these calls. They should also avoid becoming involved in price wars. Fixed voice is not a high-growth market and thus, price reductions will not stimulate higher spend. Of course, the conduct of the operators will depend on the industry structure.

Fixed operators must consider bundling voice with Internet services. They should use the increasing popularity of broadband services to develop packages that include voice and broadband. Although broadband is a new service, it could affect the number of fixed line connections and telephony channels. DSL technology allowing both voice and Internet access traffic to be carried simultaneously over a single copper pair (with one way of increasing the stickiness of fixed voice subscription. In fact, making a voice subscription a precondition for getting an ADSL service with the traditional telcos in the US is a common bundling strategy. However, in a number of markets, such as Australia, the “third line forcing” approach is illegal under trade practices legislation.

Finely balanced voice and broadband bundles in terms of price might mean slightly lower revenues than those possible from a subscriber taking both services separately, but those revenues will still be infinitely higher than those from a subscriber deciding to go “broadband-only” with a cable operator. Of course, operators with no cable broadband competition will be in a better position as they potentially face only second line

disconnections. Those up against cable broadband operators must compete using voice and broadband service bundles. Similarly, where dial-up is still the key access method for the consumers, they should bundle voice and dial-up Internet access. Voice-Internet bundles are particularly relevant when considering the weakness of mobile in this area.

The mobile market is built on device innovation, but this has not filtered through to the fixed market. Fixed operators must add value to fixed terminals to reduce the fixed/mobile differential, or create new differentials over mobile. Mobile phones are highly sophisticated terminals that are more than just a device for voice communications. In addition to their most obvious use, they can be a phonebook, a diary, an alarm clock, a radio, a camera, a messaging device, a data transfer terminal and so on. Not only are they highly functional; they are also highly personalised, with logos, ringtones and fascias. Mobile phones have evolved into a key fashion accessory, where the look of the phone is as important as its functionality.

Fixed phones, by contrast, have seen little change. The advent of cordless phones has driven sales a little, but fixed phones remain extremely beneficial. Many people use their mobile because the phone number they need is contained in their mobile handset, and it is easier to use the mobile than to key the number into the fixed handset. Intranet transfer would help to remove this barrier.

Mobile SMS has been a spectacular success, and offers minimal marketing expenditure and relatively easy technical implementation. It seems only logical that this service be extended to the fixed line user, and even more obvious for fixed line telcos to emulate mobile data functionality and maximise usage of fixed network assets.

Regardless of the growth in data applications, voice will be primary revenue generator for mobile operators for many years yet. Therefore, mobile operators also need to re-balance their attention and focus on their core voice service business.

As market develops and approaches saturation, voice ARPU is expected to stabilise. Some markets have recently experienced a somewhat artificial increase in ARPU as a result of operators removing inactive customers (those who have not used their mobile phone for a defined period of time) from their databases. With astute marketing and customer segmentation, they can still get more value from voice, and in current climate of short-term financial imperatives, the sweating of existing assets is vital.

To protect and grow revenues from voice services, operators must:

- Focus on building profitability with voice services and stimulate growth through data services;
- Become more astute in targeting different service offerings at different groups in the customer base;
- Understand the sensitivities of customers to changes in tariffs to maximise the substitution of fixed-to-mobile calls during each period;
- Prepare for the impact of next generation voice strategies. New capacity-rich (but potential under-utilised) networks may be well suited to selling large quantities of voice relatively cheaply and provide market share opportunities. Although widespread tariff

wars are unlikely, there will be increased price competition in certain high-value customer segments.

Mobile operators are attempting to persuade subscribers to abandon their fixed-line connections. There are currently numerous packages that are marketed to convince subscribers to substitute them for fixed calling plans.

Despite these marketing efforts, evidence shows that subscribers are increasingly behaving shrewdly when choosing a particular network for their calls. Rather than abandoning their fixed-line connections, subscribers are changing from fixed to mobile and mobile to fixed connections on a call-by-call basis, according to the convenience and cost. A market example can be Italy, where many consumers take out multiple mobile subscribers and are extremely knowledgeable about tariff plans. They use a number of different subscriptions according to which are cheaper at any given time (Falshaw, 2005).

Offerings to business customers should make it easier for them to integrate services into their handsets within the overall corporate telecom make-up. These services include direct interconnection between the corporate telecoms network and the mobile network, which avoids the need to interconnect via the PSTN and thus makes it cheaper for end users within the corporate network to make calls to company-owned mobiles. More sophisticated offerings may include short-code dialling, so that mobiles may be treated as extensions within the corporate network, and/or short-code dialling from mobiles to corporate extensions.

Many corporate users are generally happier (in principle) to spend a fixed amount on capital expenditure than an unknown amount on operating expenditure, so corporate sensitivity to tariffs is fairly high. As corporations look to converge mobile services more with their existing telecoms processes, price will become an increasingly important factor for subscribers when choosing between operators. The markets for voice over Bluetooth and Wireless LAN (WLAN) are likely to improve as prices are reducing and mobile solutions approach the capital expenditure cost of fixed-line equipment.

In the consumer market, retail contract subscriptions plans may be based around location-based billing, where a cheaper tariff is only available to the target users when they are within a defined “homezone”. This type of offering will ensure the generation of incremental revenues for the operator. Away from the home, in a world where people are increasingly contactable, either directly or through services such as “follow-me”, the opportunity to terminate a call, and create call minutes (as well as call minutes created for returned calls) is increasing.

Prepaid mobile has been an important source of revenue growth for many operators in recent years. The development of this market has allowed operators to gain an expanded customer base and avoid the expense of monthly billings and the account management problems associated with delinquent or late payments. The challenge facing operators in the prepaid market will be deepening the customer relationship overtime without the cost and loss of margin.

The pace that many operators are expanding and developing new product markets such as broadband and WiFi, is a direct result of the realisation that legacy voice telecoms services have reached maturity and that any future growth will come from new services.

IP voice is strategically important to fixed service providers as it offers a migration path to new convergent network-based solutions such as voice IP VPNs and hosted voice. IP voice offers new opportunities for service providers to the business market with solutions such as IP PBXs, IP contact centres, voice-enabled IP VPNs and IP Centrex. Whilst most telcos have always been an important sales channel for PBX and call-centre equipment, IP-based solutions also provide greater opportunities to add value to the sale through additional applications and management options, such as hosting and remote administration. Network-based solutions such as voice-enabled IP VPNs and IP Centrex also provide opportunities for further applications, such as video conferencing and unified communications solutions.

Another interesting trend point is the convergence of the mobile industry and consumer electronics. These new technologies are also creating challenges for traditional mobile phone vendors, such as *Nokia* and *Motorola*, as they face growing competition from new vendors with strong links to consumer electronics (like *Samsung*, *Sharp* and *LG*) (Moore and Rutter, 2004). At the same time, handset manufacturers are spinning the convergence trend to their advantage by introducing mobile phones that incorporate functionality previously monopolized by consumer electronics makers. This can be seen in the creation of the *Sony Ericsson* mobile phone brand, and *Motorola's* plans to offer new mobile phones equipped with software from *Apple Computers Inc.* which allow consumers to play music purchased over the Internet from the *Apple iTunes Music Store*.

MNO's ability to grow consumer data revenues depends in large part on how they respond to the challenges created by this convergence. To increase adoption of mobile music and mobile photography, for example, mobile service providers must enable their devices to communicate with other consumer electronics products, e.g. to download pictures from a camera-phone to a PC or upload music to a mobile music player, rather than simply interact with mobile networks. While service providers might worry about short-term "cannibalization" of mobile data revenues, the ultimate prize will have more influence over the all-important customer relationship.

Leading mobile service providers are already working with manufacturers to design their own branded devices to suit their particular target markets. In addition, they are creating branded user interfaces (portals) that provide easy, familiar access to all of their data services.

2.4 Appearance of Digital Content

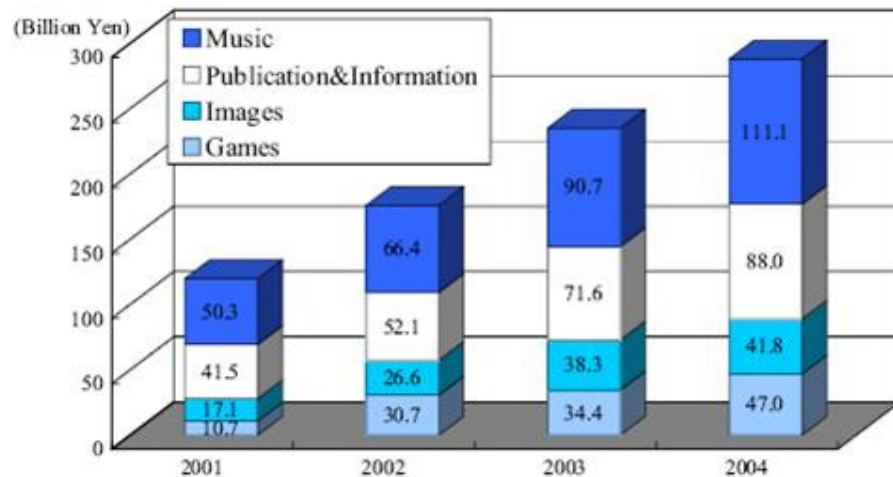
Digital content is emerging as a new economic sector with tremendous enterprise and creative potential for many countries. This new economic activity has been brought about through the convergence of previously distinct areas such as traditional content, media and entertainment, software and multimedia, and electronic hardware and telecommunications. Broadly, it encompasses the creation, design, management and distribution of digital products and services and the technologies that underpin them.

Worldwide, the market was estimated at over \$128 billion in 2001 (PwC apud Forfás, 2002). However, the industry is still some distance from maturity, having been adversely impacted by

the recent slowdown in the overall Information and Communications Technology (ICT) environment. Previous expectations for the industry may have been overly optimistic and premature. However many developments driving digital content are now only beginning and not anticipated to significantly impact the industry until exists a significant mass market penetration of broadband access and devices (PwC apud Forfás, 2002).

According to the Digital Content Association of Japan the size of mobile phone content market is increasing rapidly worldwide, especially in the Asia economies. According to (JETRO, 2004) report, the size of the mobile content market is illustrated in figure 9. A more recent study conducted by iSuppli Corp. predicts that the global market for mobile-phone premium content, including music, gaming and video, is expected to expand more than \$43 billion by 2010, rising at a compound annual growth rate of 42.5 percent since 2004 (iSuppli, 2008).

Figure 9: Size of mobile phone content market



Source: Digital Content Association of Japan (2004)

Some countries, like Ireland and Singapore, want to catch this “window of opportunity”. The intervening period between now and the industry reaching a high-growth phase, gives an excellent opportunity for these countries, during which it can carve out a place for itself in new areas of potential strength and expertise and establish a significant presence in number of high-growth/high-value digital content sectors.

Attending to Department of Enterprise, Trade and Employment (DETE) and Forfás commission, the vision of Ireland as a centre for the digital content industry is:

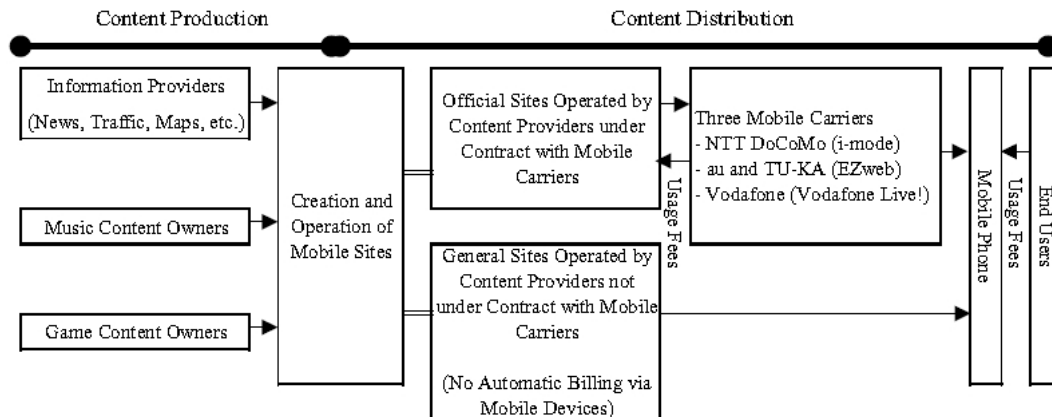
“to develop a world-class Digital Content Industry based on the targeted development of a number of clusters at the intellectual property end of the market, namely enabling technology and high-value content and applications” (Forfás, 2005).

Actually the opportunity for mobile content has never been greater than today. New generations of mobile phones are supporting new and increasingly rich content types; the volume and quality of content has been rapidly increasing due to the entry of more and more content providers stepping into the mobile market; and end-users are becoming increasingly

comfortable with downloading and streaming content to mobile phones. All of these factors are driving growth of the global mobile content market. To capitalize on the growth of mobile market, it is essential that MNOs expand their reach into content and data services to attract new customers and expand their revenue base (Hager, 2006).

The mobile content production and delivery process is illustrated in figure 10.

Figure 10: Mobile content produce and delivery process



Source: JETRO (2004)

Looking to the figure above, we can see that the content could be much diversified, such as news, traffic, maps, music or game. The content providers offer some platforms, like official sites or general sites, for content delivery by mobile carriers or directly to user's mobile phone.

The digital content industry is enormously complex and varied, comprising a disparate range of services and products across a broad range of applications, platforms, tools, and industry sectors: embracing education, information, entertainment, and consumer and business-oriented content.

The emergence of social networking sites (non mobile) is a reality and the successful ones are experiencing high levels of growth. Based on the dynamics of communities and group socialization they attract very quickly a huge number of members. But passive social-networking services that merely aggregate our friends, and their friends, ad infinitum, eventually lose their luster (Meskill, 2005).

In middle 2004, we assisted to the coining of a new concept called MoSoSo (Mobile Social Software). This concept extends the traditional social networking web based software with mobile capabilities. At present, most MoSoSos are relatively small, and service's member can only communicate with other members of the same service. Geographically mobile solutions that help us connect with our affinity groups or friends are infinitely stickier (Meskill, 2005).

MoSoSo is part of the ME (Mobile Entertainment) market. The mobile entertainment market has a huge potential. BWCS – Telecommunications Consulting and Communications (2002) estimated that the total number of mobile subscribers worldwide was more than 1.72 billion by the end of 2007, compared to 950 in 2001.

This market has a huge opportunity but there are some trends that can represent complex challenges or additional opportunities in the short/medium term. In the table below is a summary of some of those key trends:

Table 1: Some mobile entertainment key trends

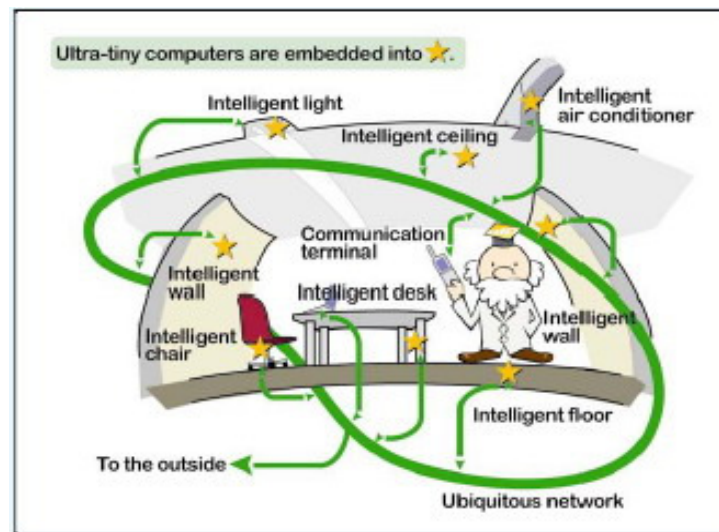
Technology driven trends - identification of a user (biometrics: retinal scanning, fingerprint detection, voice identification); - interoperability; - location based technologies; - pervasive (ubiquitous) computing; - PAN, WLAN (social connections); - multiple media solutions.	
Customer and market driven trends - e-commerce (Mobile Wallet); - local user innovations; - price level decreasing; - difficulties with pricing: additional prices not easy to get; - communities; - market going towards disposable products, trend and fashion leading development.	Global trends - globalisation continues; - “China phenomenon” - local and global markets differ still greatly; - life span of products decreasing; - knowledge of ICT and the possibilities of use increase on every sector; - demand for more rich experiences and diverse usage of ICT devices.
Industry alteration trends - production of devices and content cheaper in countries like China and India; - networking of small ME companies continuing strong; - formation of few central aggregators of content products; - concentration of the industry; - fusion will create larger and competitive companies.	Environment trends - recycling; - re-designing the life span of the products; - miniaturisation of devices; - environmentally friendly use of energy.

Source: *mGain*, 2003

The mobile communications begin to converge with truly “ubiquitous” technologies such as wireless sensor networks and Radio-Frequency Identification (RFID). Mobile phones, and so called “smart phones”, will soon become gateways to information not only on the World

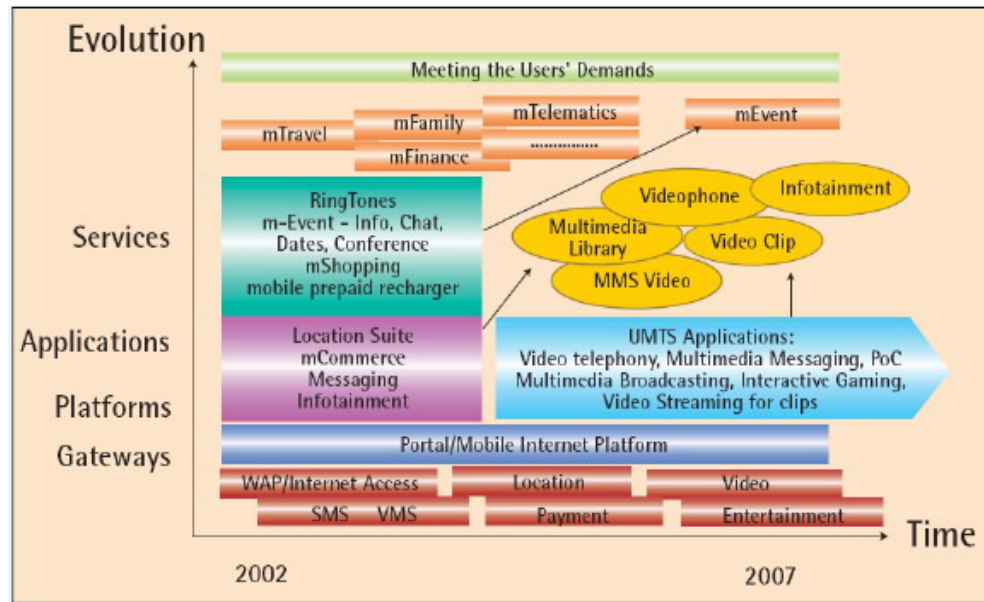
Wide Web (WWW), but information contained on all types of things, from appliances to everyday consumer items. Mobile communications, in combination with ubiquitous computing, will create ambient networking environments in private homes, offices and public spaces (figure 11). In this respect, global dialogue between the public and the private sectors, between service providers and consumers, is vital in forecasting a healthy and user-centric mobile multimedia future.

Figure 11: From smart mobiles to ambient networking



Source: Ubiquitous ID Centre (Japan) as cited in ITU Internet Reports, 2005

User demand in a future mobile multimedia environment can be said to consist of three principal dimensions: mobility, ubiquity and identity. The first dimension, mobility liberates the user from a specific location, through portable access methods. The second dimension, ubiquity, liberates the user from a dedicated device for access, and the third dimension liberates the user from the manual communication of identify (e.g., through passwords).

Figure 12: The evolution of multimedia services

Source: ITU, as cited by UMTS forum, 2006

The ambient mobile communications enable users to share awareness information without explicit interactions, and viewing it can be as simple as opening one's phone in an idle moment. Shared information can range from locations and activities of friends and family to music they are playing or events they are attending. This simple interaction can maintain social connections and conveniently spark new communication around the information exchanged. From monitoring children or elderly to finding new music or places to meet friends, there are many useful applications in this space. Early implementations and user tests show promising results (CHI2006.org, 2006).

The concept of ambient mobile communications can be seen in aspects of several existing systems. *WatchMe* is a prime example which allows people to view the current location and mode of transportation of a contact and to "send a smile" which is a lightweight form of communication. Other examples work on proximity to allow users to access information about others in their environment. Projects such as *DigiDress* allow users to browse public profiles of people in their vicinity providing for potential communication with strangers while systems such as those developed by *Vetere* allow intimate users to communicate in lightweight ways throughout the day.

Another recent concept that is growing quickly is the M-Commerce. Mobile Commerce is the use of information technologies and communication technologies for the purpose of mobile integration of different value chains and business process, and for the purpose of management of business relationships.

The basic idea of M-Commerce is to distribute information and thus to generate business in a mobile way. M-Commerce gives traditional media (newspapers, magazines, TV) the opportunity to supply different pieces of information to millions of users, and, in the end of

the day, to earn money from reusing their content. These ideas are supported by a variety of predictions, most of them base on the sales figures of mobile phone devices.

Prepayment models have been a key driver in the take-up of mobile services, particularly in the developing world. In a similar vein, prepayment can be used to drive take-up of multimedia content such as ring tones and audiovisual content. Prepayment via mobile phones has also been extended to others services. For example, in the United Kingdom (UK), *Logica CMG* and *Iskraemeco ECL* have developed an electricity and gas prepayment metering services based on SMS messaging and a pay-as-you-go scheme (mGain, 2003).

In several countries, including the United Kingdom (where one of the first m-ticketing services in the world was developed for the Ministry of Sound Nightclub in 2001), Australia and Japan (where railway tickets can be bought and redeemed using mobile phones), various mobile ticketing schemes have been developed and used. These include ticketing via SMS, mobile barcodes and RFID systems.

The mobile multimedia is also a big market place for advertising. The popularity of SMS messaging has encouraged advertisers to focus on this new media, which is viewed as far more successful than direct mailing. Issues which need to be addressed include not only the content of such advertisements, but how they can be distinguished from spam. One of the key questions is whether content requested by a user, which is then sent to a mobile phone, should be regulated. Moreover, with the growth of multimedia services, 3G mobile phone companies have started selling advertising, enabling advertisers to focus on targeting particular groups of individuals.

An important challenge in developing regulation for advertising on mobiles (whether in the form of SMS, MMS or other multimedia content) is the fact that mobile advertising is, at this stage, still in its infancy. For example, advertisers and the mobile phone industry have not yet to come up with a successful mobile advertising model, and consumer reaction to mobile advertising has not yet been gauged. There is uncertainty about the appropriateness of existing models and, although advertisers have recognized the tremendous potential of targeted mobile advertising, it is an area which is likely to undergo some experimentation.

2.5 Intensity of Competition and Regulation

There is a constant debate about the relative roles of competition law and regulation in telecommunications. The issue is sharper here than in other network industries such as energy, water or transport, because in telecommunications many of the activities undertaken fail to fit neatly into the categories of being either natural monopolies (such as a railway line or high voltage transmission grid) or of being capable of workable competition in a relatively short period (such as gas retailing). In fixed telecommunications the scope of competition replication of assets across the value chain seems to vary almost continuously between these two extremes, from the local loop, which in the absence of cable networks is very hard to replicate, through core networks (which are often replicable), to retailing (where entry is fairly easy).

The two basic means by which public institutions directly influence the structure of the telecommunications industry are general competition law and sector specific regulation. The latter is a prescriptive approach in the sense that the regulator imposes certain behaviour and standards on firms prospectively. In contrast to regulatory activity, general competition law is a proscriptive approach which prohibits certain courses of conduct but leaves firms doing what they like as long as they avoid such practices. Therefore, competition law is considered to be a less interventionist approach than regulation. Competition law mainly applies remedies retrospectively (i.e., after a wrong doing) only but economy-wide in multiple industries.

In the telecommunications, the pace of change is much faster than elsewhere. Since 1990, mobile networks of successive generations, the Internet and broadband have transformed the face of the sector, at the same time that convergence has transformed market boundaries.

In the 20th century, the telecommunications industry had almost everywhere been viewed as a public utility, mostly supported by the public ownership of telecommunications companies or strong controls by the government went with that. Today, after privatization processes and introduction of competition in the telecommunications market in many countries, the specific challenges of public intervention stem from the fact that most incumbents are still able to continue to dominate their markets and enjoy significant advantages even though competition has been officially introduced. Incumbents control essential facilities, they benefit from the economics of established networks, have vertically integrated upstream and downstream production facilities, strong control over network standards and their development, cab cross-subsidy products and services and they profit from customer inertia which makes it difficult to convince consumers to switch suppliers. These problems of market imperfections cannot easily be handled by general competition law, and consequently the transitory process to competition has in many ways to rely on regulatory activity. The mobile telecommunications market, however, is exposed to these kinds of problems, because of a higher number of operators in an early stage of market development. This fact triggers discussions on whether sector-specific intervention in the mobile telecommunications market is necessary or whether competition law is sufficient as a mechanism of market control.

Now, we take a brief look to the competition law in the telecommunications sector for three different countries: United States, United Kingdom and New Zealand. These countries were chosen to illustrate particular points of interest such as relevance and innovation approach, and not to be in any way to provide a comprehensive summary.

United States

US competition law was the source of the major experiment in structural engineering of the telecommunications sector – the break up of the Bell Systems in the 1980s under US competition law, following what was seen as the failure of the regulatory regime to provide an adequately pro-competitive environment (Cave, 2006). Despite this, however, competition in local services languished for the next decade.

The passage of the 1996 Telecommunications Act created a new common carriage access regime based on a version of long run incremental cost, and the Federal Communications Commission (FCC) implemented it vigorously, requiring the incumbent local exchange carriers to resell their combined services in the form of unbundled network elements – platform (UNE-P). The regime was not calculated to encourage investment by competitors, however, and was also subject to legal challenges. The FCC in 2005 issued new, and significantly less comprehensive unbundling rules.

Rather than relying upon standard market analysis techniques from competition law, the 1996 Telecommunications Act maintained from previous legislation the distinction between telecommunications service, which is subject to common carrier regulation, and information service, which is not. Policy towards broadband hinged on this distinction, with first cable modems and subsequently ADSL being declared to be not subject to regulation as a telecommunications service.

The overall effect of these measures was to limit the regulation of markets on the basis of arguments based on considerations internal to the specific legislative framework, not the application of competition law principles. The distinction was to some degree confirmed by a Supreme Court case of 2004, in which the Court ruled that the Telecommunications Act provided adequate regulatory over-sight of anti-competitive behaviour and that relief for alleged victims of such conduct under the anti-trust laws was not available (Verizon Communications, 2005). The judgment drew attention to the differences between the 1996 Telecommunications Act and the antitrust laws: the former attempts to eliminate the monopolies enjoyed by the inheritors of AT&T's local franchise whole, the latter seeks merely to prevent unlawful monopolisation rather than the use of monopoly power.

United Kingdom

The UK communications regulatory body Ofcom (and its predecessor OFTEL) shares with only one other member state of the European Union (EU) the property that it implements both regulatory policy, now set out in the Communications Act 2003, and the UK's competition law, notably the Competition Act 1998, which replicates articles 81 and 82 of the Treaty, and the Enterprise Act 2003. This regime gives added flexibility and may enhance coherence. For example, Ofcom can address the pricing of wholesale broadband access (bitstream) using its regulatory powers, while the issue of whether BT is practising a margin squeeze in relation to its retail price of broadband and the price at which it provides a wholesale broadband product for resale by its competitors is dealt with by the same body under the Competition Act 1998.

The advantages conferred by concurrency were also visible in Ofcom's conduct of its Telecommunications Strategy Review. This concluded that regulation should be focussed on enduring bottlenecks, and that there was evidence that BT has the means and motive to practice non-price discrimination in the provision to competitors of the key access products such as unbundled local loops and wholesale line rental.

The problem, Ofcom concluded, could be addressed by requiring “equivalence” in the supply of such products, supported by the creation of a separate access services division with its own governance and incentive structures. The Enterprise Act 2003 is a piece of competition legislation peculiar to the UK which allows scrutiny of persistent competition problems in a sector, and its reference if necessary to the UK Competition Commission, which has powers to impose either a range of behavioural remedies, or structural separation. Under this Act, Ofcom accepted undertakings from BT, in lieu of a reference to the Competition Commission, designed to deal with the problems described above. Breach of these undertakings would lead to a fine. This experience naturally raises the issue of whether the remedy should be applied elsewhere and how, in the absence in other countries of an Enterprise Act, this could be done.

New-Zealand

New-Zealand has the distinction of relying until recently entirely upon its competition legislation, the Commerce Act 1986, to regulate its network industries. As a consequence, issues of access by competitors to the incumbent telecommunications operator’s assets were decided under section 36 of the Act, which prohibits a dominant firm from using that position to restrict entry, to prevent another firm from competing or to eliminate a rival (Cave, 2006).

This led to protracted legal case as to whether access prices charged by the incumbent, based on the so-called efficient component pricing rule were lawful. According to this rule, the access price equals the incremental cost of provision plus the incumbent’s opportunity cost. This can produce an access price considerably in excess of cost. The matter was finally resolved in favour of incumbent by the Privy Council in London.

Subsequently the government passed the Telecommunications Act 2001 which allows the Telecommunications Commissioner (appointed under the Act) to impose obligations to supply access services either according to a pricing principle (designated services) and this without a pricing principle (specific services). Determinations can only be made following an elaborated cost-benefit test.

The regime has been criticised for being cumbersome and for failing to allow the broadband market to develop adequately, in the absence of unbundled local loops. A stocktake of current arrangements has now been undertaken by the government, and this has resulted in a decision to extend mandatory access to the dominant carrier’s assets.

This is a major departure from the earlier policy of reliance on competition law, which the New Zealand Government has now found to be ineffectual.

The experience of these three countries thus shows a continuing need for regulation, but a tendency to confine its area of application and to rely increasingly upon competition law.

In European Union, a great example of the convergence of competition law and regulation is the new European framework for regulation of Electronic Communication Service (ECS),

which came into force in 2003 and is already subject to a debate over how it should be reformed from 2010.

The main objectives of the new framework are to simplify the previous regimes, to apply them in a technologically neutral manner, and to encourage competition while guaranteeing user rights. Certainly, the previous regime has been streamlined, through a reduction from around twenty key communities law measures to just five. At one level, the new regime is a major step down the transition path between regulated monopoly and normal competition, governed exclusively by generic competition law. As a result of the new regime, NRAs are no longer able to regulate the sector by issuing individual licenses, and subject only to certain limited exceptions, member states are required to establish a general authorisation regime.

A list containing the most important international regulation entities is available in the Annex A of this thesis.

The goals of regulatory activity in the telecommunications industry can, on a very aggregate level, to be described as to promote competition and to supply a country with sufficient and adequate services, but there are much more specific widely accepted regulatory objectives in the public interest, laid down in economic literature and telecommunications acts. The typical ones are:

- To foster competitive markets and, where they do not exist, to prevent abuse of market power;
- To establish an efficiently priced supply of good quality basic and advanced telecommunications services;
- Access to basic telecommunications services for everyone (universal access).

In this context regulatory authorities assure:

- Fostering of competitive markets (e.g., frequencies or rights of way);
- Public and consumer protection in all related respects;
- Creation of a favourable climate for investments in the telecommunications sector.

Yet it is only the so-called “public-interest” theory which takes the sanguine view that the above reasons for regulation are indeed the main motivation for why markets are regulated. Today people are very much aware of potentials of abuse of sector-specific interventionist activity and the fact that regulation can be influenced or even triggered by industry interests.

The most common instruments of regulatory intervention are:

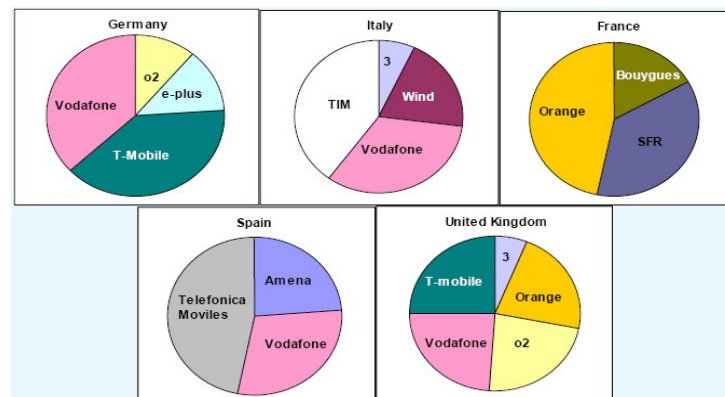
- Control of entry;
- Control of prices;
- Control of earnings;
- Setting of quality standards.

In many respects, these instruments are not separable. Here they will be briefly sketched for an overview.

Entry restrictions are most visible where licenses are issued, e.g., for the operation of mobile telecommunications networks. Access issues are also dealt with if competitors need access to facilities owned by other companies, for example to the local loop in telecommunications networks or to the infrastructure of mobile communications systems for Mobile Virtual Network Operators (MVNO). Mandated access to facilities in most cases goes along with specific prices which are to be charged for access. Therefore price controls are among the most common regulatory instruments and can take many forms. A regulator might require firms to obtain approval for each price they set or impose price cap regulation, which means that all prices on average may not exceed a certain specific level. The control of mobile termination charges is a matter of price regulation just like the terms at which operators get access to the local loop from the incumbent in the telecommunications market. Control of earning is another important measure, usually put in place to prevent companies not restrained by full competition to generate unreasonable profits. Rate-of-return regulation, widely practiced in the United States during the 80's is a good example. The regulator would calculate an allowable rate of return on assets high enough to cover costs and sufficient to maintain investor's willingness to replace and expand the companies assets. Regulation is fruitless if quality is not maintained at a specific level. So, finally, the setting of quality standards is an important yet often disregarded regulatory instrument in the utilities industries where, due to the limited number of suppliers, quality can sometimes only be secured by public control. For example, generally reliability of service at a specific level, such as the percentage of dialled calls completed, are important in the telecommunications sector.

Looking to Europe, the overall mobile market share of the incumbent networks is more than 40% in 13 member states. Here we can take a brief look about the market concentration in the major western European markets (figure 13).

Figure 13: Market shares of mobile operators



Source: IDATE, 2006

2.6 Competitive Strategies

Global competitive strategies depend significantly on substitution across established network technologies, the evolution of new local competitors, and the importance of service innovation.

There are some generic global strategies that a telecom operator can follow: competition based on price, differentiation and focus.

Competition on price has been a long-time strategy for many telecom firms, but winning customers on price, rather than on services and support, dilutes a telecom provider's value, says David Hawley, senior analyst of telecom software strategies at the Yankee Group. "Undifferentiated services force carriers into price wars, which force customers to focus on the price point. When that happens it becomes difficult to dominate if you're just competing on price" (Myron, 2004).

Mark Heath says that "pricing decisions have never been more important for mobile operators" (Heath, 2006). In fact, pricing has an immediate role to play in maintaining and growing mobile voice usage and ARPU, and kick-starting much-needed new revenue from mobile data services. It can also have a major impact on the relationship between operators and their customers, and the long term effects of this on churn and price competition. However, mobile service pricing is a complex subject, complicated by the sheer diversity of services, and mobile operators face many pitfalls. Mark Heath also says "operators must attempt to extract the full revenue potential of each service while taking account of a wide variety of factors, including affordability for end-users, the unique capacity and cost limitations of cellular technology, and the ability to differentiate from competitors".

We can consider that pricing has a critical role to play in growing voice revenue and stimulating take-up and usage of new data services. However, wrong pricing decisions now could create barriers to growth and may have long-term consequences (Myron, 2004). Bundled pricing, when properly implemented, is a powerful technique to drive revenue growth in the short and long term. A bundled package promises one bill from one provider for two or more of a customer telecommunications needs like local, long-distance and wireless phone calls, Internet access and pay TV services.

Bundling first emerged in 2002, when deregulating dating back to the Telecommunications Act of 1996 made it possible for regional Bell operating companies to carry long-distance service. Actually, we have long-distance companies competing in the local calling markets while offering Internet and TV services as well. Telcos like *AT&T*, *SBC* and *Verizon* are often in the unique position of having customers using several of their products (e.g., wireless, local and long distance services, Internet services). To stem high churn rates many operators are looking to bundle services. Empirical evidence shows that the more services customers purchase from an operator the less likely they are to churn (Mulrean apud Myron, 2004).

According to Hawley, bundling two services usually reduces customer churn by 25 percent. Bundling a third product reduces it by an additional 13 percent, and a fourth product reduces churn by an additional 6 percent.

Other competitive strategy that is becoming even more important than the previous is to create differentiated products and services to specific customers segments. This strategy usually associates together two very important approaches: differentiation and focus. To achieve a competitive edge through a differentiated customer experience, telecom operators need the ability to respond rapidly to constantly changing customer and market expectation.

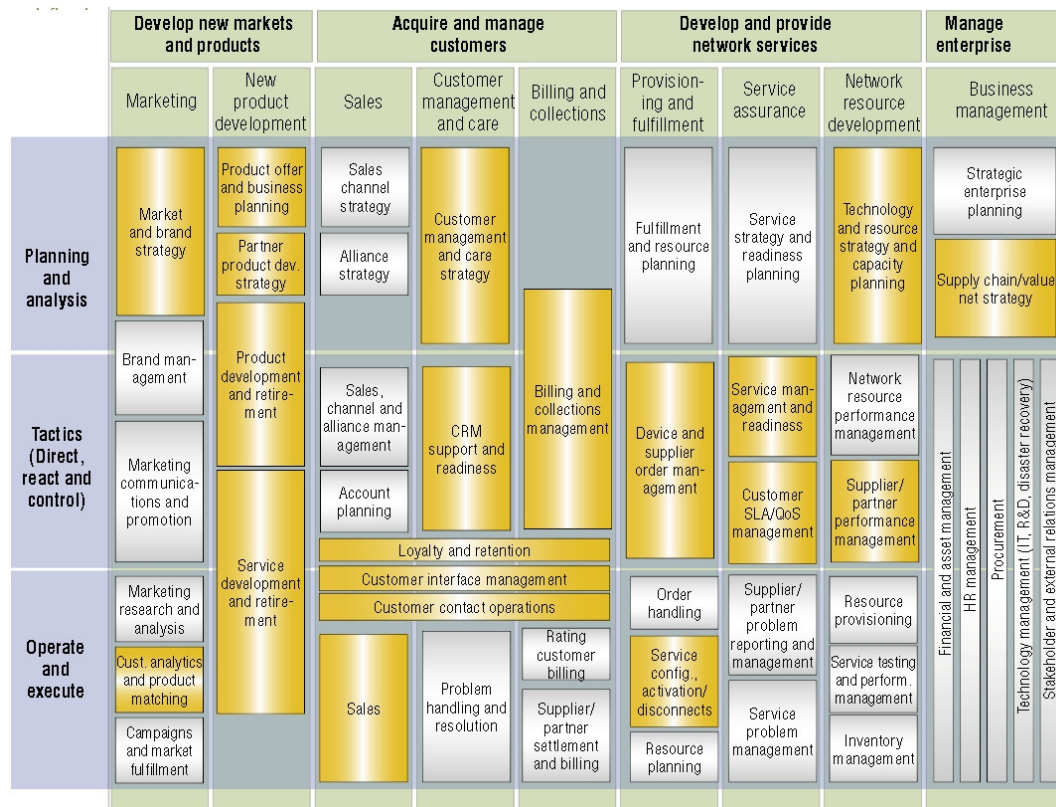
In this strategy the firm concentrates on a select few target markets. It is hoped that by focusing marketing efforts on one or two narrow market segments and tailoring the marketing mix to these specialized markets, the needs of those target markets can be better met. Using these two approaches together companies try to move towards an operational excellence, product innovation and customer intimacy.

Telecom operators focus on those few capabilities that directly support differentiation, rather than pursuing a comprehensive strategy aimed at being the best in every aspect of the value chain. To lower costs and achieve better results, it frequently relies on strategic partners to provide what they do best. A focus telecom operators targets selected high-value market segments for retail sales, while pursuing increased wholesale and indirect sales through others that are better positioned in other segments. On demand telecom operators are responsive to the accelerating pace of change in the industry and spend less time revamping inflexible business models that are dependent on successfully predicting the future. To heighten responsiveness, they establish more flexible product development platforms and buy their computing resources on demand. Peak loads are managed through resource sharing, grid computing or outsourcing arrangements. Open systems and the associated increase in business partner collaboration allows these operators to shorten product development cycles and lower development costs.

To combat unrelenting financial pressures and capital scarcity, on demand telecom operators migrate their costs structures to more variable models, moving away from committed investments in fixed assets and toward scalable (both up and down) service development and delivery platforms. Their flexibility allows service portfolios to evolve in line with market needs, with a scalable back-end ready to support new offering. On demand mobile companies run resilient operations that offer optimum reliability to clients in a world of unpredictable threats.

IBM has developed a new analytical tool entitled Component Business Modelling (CBM). A component business model is a logical representation, or map, of an enterprise that reveals its essential building blocks or business components, which is a part of an enterprise that has the potential to operate autonomously. It has discrete boundaries, defined by the services that it uses as inputs and offers as outputs. This methodology helps businesses identify which components of their business directly support differentiation and where redundancy and overlap can be eliminated to cut costs.

Although each company's model is unique, using a standard model developed for a "typical" telecom operator is also very useful. This methodology has identified specific business components that exhibit potential for providing a differential customer experience (see figure 14) and other components where cost is not consistent with value produced.

Figure 14: CBM highlights which components of the business support differentiation

Source: IBM Business Consulting Services, 2004

This method analyzed the four primary areas of a typical telecom operator business: new product development, customer management, network services and enterprise management. These key capabilities emerged as high priorities for a telecom operator that wants to become an on demand business. Next we present these proposed key capabilities.

Keeping the product portfolio fresh and profitable

To attract and retain high-value customers, telecom operators will need to provide innovative products that suit targeted market segments. Four primary product development and innovation competencies will be crucial:

- Product portfolio management targets the right investments in development, by considering ROI, strategic direction, risk and other critical success factors;
- Process management creates efficiency across the full product lifecycle, from concept to service;
- Partner management means having the right partner and supplier strategy to effectively bring products and services to market; with an historical bent toward providing customer solutions on their own, delivering through collaboration with partners is a new but critically important skill for a telecom operator;
- Platform management establishes the right architecture to deliver more products, better leveraging development and deployment expenditures.

Platform and partner management are particularly critical in the area of mobile portals. In recent years, branded portals have become a key strategy to capture value from emerging data market opportunities. From a mobile network operator perspective, portals should make new services easy-to-use and create familiar customer experience through a consistent “look and feel” for all services. *Vodafone* epitomizes this approach with its “Vodafone Live!” portal; as the company deploys the portal across its various properties, competitors are busy imitating it in regional and local markets.

To create greater value for end-users, MNOs are delivering these portals through “collaborative ecosystems” that leverage each partner’s unique competencies and their combined scale. Since MNOs play a central role in these ecosystems, the structure and execution of their business relationships often dictate the success of the portal. Platforms based on open standards enable easier integration of business partner content and applications, streamlining the introduction of new services. Flexible platform and partner management allow MNOs to respond to the data services opportunity in collaboration with their business partners, attracting and retaining a greater share of the marketplace.

One example of this approach is the *Mobilkom*. *Mobilkom Austria* prides itself an extensive set of data services, and delivering those services as quickly and efficiently as possible. Yet, service provisioning is a complex process that requires close integration with various third-party content and service providers and consistent delivery despite the number of applications, platforms, channels and devices involved. To accelerate introduction of new services and lower development costs, *Mobilkom* implemented a new service management platform based on open standards called Access and Service Management Platform (ASMP). Besides providing customers with access to innovative new services much faster, ASMP offers customers a single sign-on capability that encompasses all applications connected to the platform.

Upgrading customer-centric service to differentiated experiences

Using a MVNO business model, niche mobile service providers are starting to challenge the major MNOs by focusing on delivery of a unique customer experience that appeal to a specific customer segment. For example, *Virgin Mobile* has had success in several markets with its edgy, non-traditional marketing and targeted service propositions.

Although most telecom operators have made progress with becoming more customer-centric, full-scale customer management, encompassing customer service, revenue stimulation and retention, which are presented an even greater challenge today, as telecom operators strive to deliver differentiated service across multiple market segments and increasingly complex operations. Enhanced capabilities in key areas will help all mobile service providers to differentiated customer experiences:

- Multi-channel customer self-service. Broad-based Internet adoption, technological advances and increasingly sophisticated mobile devices have created new possibilities for customer service, along with elevated customer expectations. Today’s customers want access to customer service through whatever channel is most convenient for them, e.g., call center, web site, retail location or the mobile device itself;

- Advanced analytics. More sophisticated analytical capabilities enable service providers to understand the needs and relative lifetime value, or profit contribution, of individual customers;
- Customer service performance tracking. Electronic tracking of customer service performance enables mobile service providers to monitor the impact of service provision continuously and identify weaknesses and areas for improvement without delay;
- Billing flexibility. As billing requirements escalate, so do costs. Mobile customers expect real-time information and seamlessly integrated services, devices, network capabilities, applications and content.

Meeting new-generation needs with next-generation networks

Successful new product development and rollout are critical for telecom operator differentiation and revenue growth. The network plays a crucial role in enabling these top-line objectives. New wireless and Internet technology advances, and more complex customer needs (such as multimedia content delivery, enterprise solutions and integrated offerings, including customer service and billing), are placing greater demands on their telecom operators legacy networks, which hamper their ability to meet escalating service level expectations. With digital wireless merging mobile telephony with mobile computing, and data and content integration within standardized Internet context, mobile operators need to offer bundled, value-added services that help attract and retain the most profitable customers. Delivering against these requirements requires transformation of current mobile networks to IP-based, next-generation networks will open architectures, customer self-service and simplified network management, without service delivery disruption and in a cost-effective manner.

Next generation networks give to telecom operators the flexibility to provide services on demand through a well-formulated service delivery platform. Open architectures make it easier to integrate third-party content and applications. This type of homogenous environment also helps reduce costs and simplify network management, allowing higher-skilled engineering staff to invest the bulk of their time in revenue-generating product initiatives instead of network operations.

One example of this was cited by *IBM Business Consulting Services* in their report “Upwardly Mobile”. A leading European mobile telecommunications provider decided to implement a new Intelligent Network (IN) platform to significantly increase its ability to launch new, quickly and cost-effectively voice services. Based on open standards, the platform is expected to reduce the development cycle for new services by 50 percent, allowing the company to enter new markets and bring in additional revenue more quickly. As a substantial side benefit, the simplified environment should also cut ongoing maintenance costs by some 25 percent. With a goal of retaining all of its existing VPN and prepaid customers during its network transition, the company has mapped out a careful migration strategy to avoid disruption. The entire solution is designed to be expandable as traffic rises, and can easily scale to support the company’s subsidiaries in other parts of Europe.

Finding funds for transformation within enterprise management processes

Although enterprise processes, such as supply chain, finance and administration, Human Resources (HR) and Information Technology (IT) do not typically contribute to mobile operators differentiation, they offer tremendous sources of potential cost, savings that can be channelled back into differentiating investments.

Telecom operators are only beginning to tap these types of funding sources. Many have outsourced HR and some subset of IT support, but few have evaluated their finance functions for potential outsourcing opportunities. Years of growth-through-acquisition have left telecom operators with a hodge-podge of legacy systems and redundant resources in their finance departments. As telecom companies become more focused on differentiation capabilities, and more comfortable relying on partners that can provide superior levels of service in the remaining areas of their business, finance will likely emerge as the next frontier for business process outsourcing.

3 Business Models for Telecom Companies

3.1 Short Overview

In this chapter we present the most important business models for a telecom company. In a first instance (section 3.2) we introduce the notion of business models and value chains. Consecutively (section 3.3) we take a brief overview of classical business models, looking especially to the evolution and importance of pre-paid and post-paid markets. Later (section 3.4) we look to the current value chains and business models. In this section we examine several value chains, namely the Internet, mobile, broadcast and the hot-spot industry value chains. At last (section 3.5) we briefly present the major new emerging value chains in the telecom industry that includes: the 3GPP IP Multimedia System, the mobile broadcast convergence and the ambient networks.

3.2 Introduction to Business Models

A business model may be defined as an individual company's set of choices about what to do and how to do it. Many various environmental aspects may be of great importance. Focus of approach is business strategy, industrial organization and competitive power, but other aspects such as underlying needs of the customer and government policy (regulation) may be crucial.

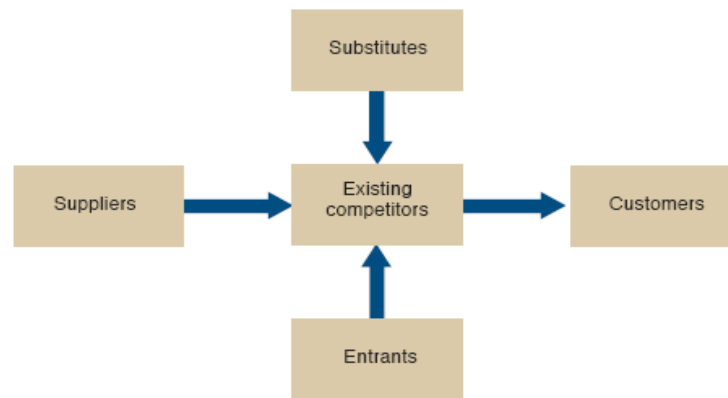
In a high level description, a service provided by a telecommunications network is the result of an execution of a function. Some functions go hand in hand and cannot be separated either from a business or a technology perspective. The smallest set of functions that cannot be further divided constitutes a role.

The “eco-system” of the telecommunications industry consists of several roles and interfaces between them. The providers of access, switching, transport, service platform, billing, or customer handling, each constitutes a specific role. A player, or a firm, on the other hand is a collection of several roles.

It is important to make the distinction between players and roles. The traditional telecommunications operators will often cover many of all roles, mostly due to their history with monopolies and vertically integrated value systems. Breaking up, these systems have given rise to new business players like resellers and service providers.

Value Chain

The standard approach to the analysis of industry attractiveness is Michael Porter's Five Forces framework. The attractiveness of an industry, such as the telecommunications industry, depends on the state of competition and the state of competition in an industry depends on five basic competitive forces. The figure 15 gives a picture of the Porter's Five Forces framework.

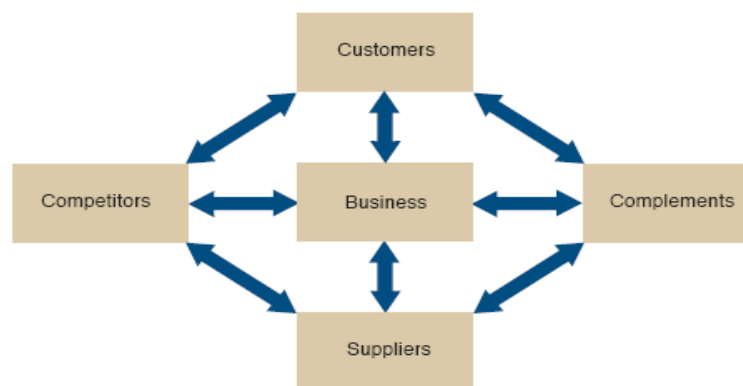
Figure 15: Porter's five forces

Source: Porter, 1985

The power of five forces – Suppliers, Customers, Potential Entrants, Substitutes and Rivalry among existing firms, depends on some major factors and characteristics listed in the work of Porter. In his book “Competitive Advantage”, Michael Porter suggested analyzing the “cost leadership” and “differentiation” strategies by means of the value chain model, which has become the standard approach to these analyses. An effective competitive strategy according to this approach takes offensive or defensive action in order to create a defensible position against the five competitive forces.

Value Net

The Value Net can be seen as a generalization of the Five Forces framework. Complements are added as a new dimension. The Value Net emphasizes that the value to the customers can depend on a package of complementary services and/or products. Logically, complements will influence the attractiveness of an industry. Figure 16 gives a picture of the Value Net of a company.

Figure 16: The value net

Source: Porter, 1985

A player can be understood as a complement if customers value their product more when they have that player's product than when they have their product alone. A player is a

competitor if customers value your product less when they have that player's product than when they have their product alone.

To draw the map of the whole Value Net of a company (function) of the telecommunications industry is more and more challenging due to increasing complexity of relations between companies within the ICT business landscape. The number of companies and types of unbundled functions are increasing. Companies can to various degrees be both horizontally and vertically integrated. In addition, companies can be present in several countries (local markets). Further, the number of different technologies (e.g., access technologies) and the number of products and applications are increasing. Various sources of payment (e.g., from subscription, advertising and transaction) can also increase the level of complexity and the relations between roles and companies.

Value Networks

Stabell and Fjeldstad suggest that Porter's Value Chain framework is only one of the three generic value configurations, the other two being "value shop", which describes a firm where value is created by mobilising resources and activities to resolve a particular customer problem (e.g., hospitals, professional services and educational institutions), and "value network", which may be used to model firms that create value by facilitating a network relationship between their customers using a mediating technology (e.g., telephone companies, transportation companies, insurance companies and banks). Fjeldstad claims that the Value Chain model and the related Five Forces model do not reflect the strategic logic of mediators, and in particular fail to incorporate positive network externalities both as a source of competitive advantage and as a barrier to entry and innovation.

Like the value chain, the value networks model distinguishes between primary and support activities. Primary activities are those that create value for the customers, which in the case of telecommunications are those involved in selling and providing a service. Support activities are engaged to perform effectively the primary activities of the firm.

According to Fjeldstad the primary activities of a telecom operator's value network are:

- Marketing and contract management, which consists of activities associated with inviting potential customers to join the network, the selection of customers allowed to join, end the initialisation, management and termination of contracts governing provisioning and charging;
- Service provisioning, which consists of activities associated with establishing, maintaining and terminating links between customers, and billing for value received. Billing requires measuring customer's use of the network capacity both in volume and time;
- Network infrastructure operation, which consists of activities associated with maintaining and running a physical and information infrastructure. These activities keep the network in an alert state, ready to service customer requests.

Support activities include product and process development (development and implementation of new services, reconfiguration of network infrastructure, development of

new technology and implementation of standards), human resource management and procurement.

Fjeldstad denotes multiple firms contributing to the creation of a service as a co-productive value system. In such industries co-production takes place both between horizontally interconnected firms and between vertically layered firms. Unique structural properties of the telecommunications industry following the patterns of horizontal and vertical co-production are critical to understanding the nature of competition.

Besides that, it is important to establish the difference between effectiveness and strategy. Strategy should not be confused with operational effectiveness. Strategic positioning means performing similar activities in different ways. Porter argues that robust strategies involve trade-offs. A company must abandon or forget some products features, services, or activities in order to be unique at others. Further, strategy defines how to all the elements of what a company does, fit together.

3.3 Brief Overview of Classical Business Models

The industry of telecommunications has changed hugely, and associated with that, all the classical business models have been adapted to the technology changes and customer demands. Typically old telecom companies built and invested a lot of money in the infrastructure of telecommunications. The ownership of physical lines was during many years a critical factor of the success in this area of business. However, at the same time the telecom operators faced the rollout of their revenues. The pricing power is fatally destabilized with the increase of industry price wars and the price and value are fundamentally disconnected.

The customers want the “lowest price at any cost” and a new package of functionalities that suggests an increase investments by the telecom operators. The market demanded big investments by the telecom operators, but customers are only prepared to pay incrementally. The competition between operators increased severely and they look for new customers. However, the concept of “attracting new customers” isn’t enough, and the operators try to attract new customers from other operators and sell new services to the current customers. Actually, customers have little or no loyalty to the telecom providers.

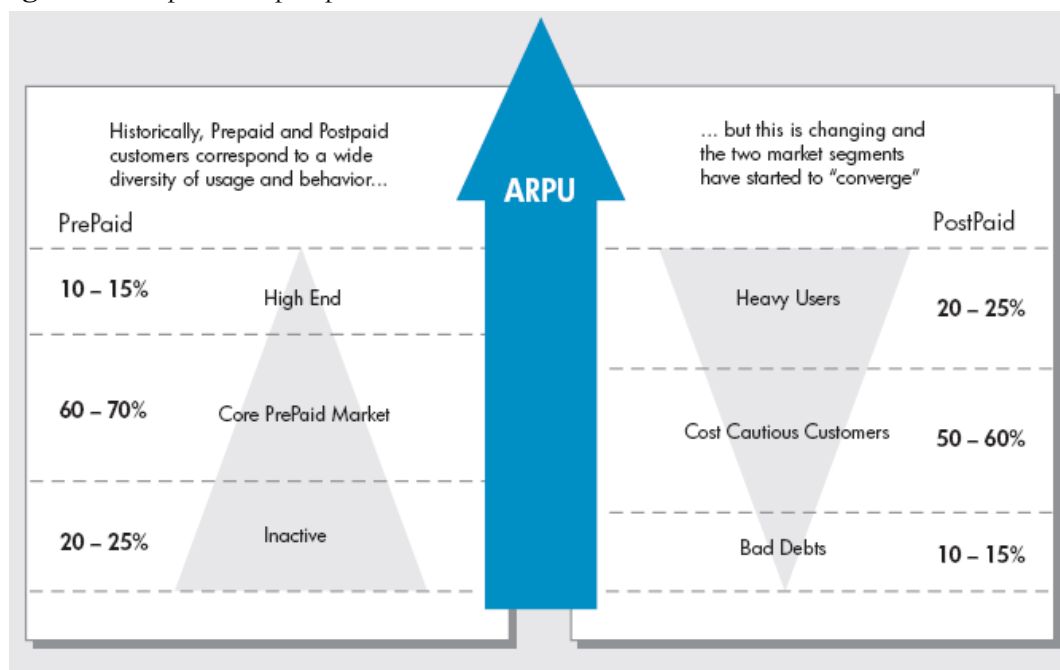
During the last years, technology innovation was a key factor for success. Innovation, knowledge creation and learning have become key drivers for corporate competitiveness in knowledge-based competition. In this innovation era, organizations are faced with challenges on how to increase and measure their innovativeness (Blomqvist and Ojanen, 2004).

Telcos face a very challenging competitive situation. The harsh competition and the emerging new technologies may be a real threat for the present business models based on traffic in cellular networks. It is critical for a Telco’s R&D strategy and related R&D portfolio to address the threats and opportunities posed by the high pace of technological change. However the innovation can’t focus only the technology vector to create a new service with value to the customer. According to Miller (2001), it’s crucial to attend these three categories: 1) human capital, 2) information capital and 3) organizational capital.

Following this theory, human capital can be seen like the core for continuous innovation, and firms must learn new strategic thinking and a new organizational culture. In this approach for innovativeness a firm's ability to empower the human capital, and to communicate its strategy and vision are addressed. Also the firm's customer-orientation and its ability to create trust, time, inter-organizational and intra-organizational space for mutual knowledge creation are the source for a sustainable innovation policy.

Telecom operators use typically a transaction mentality and approach with two different basic business models: prepaid and postpaid systems. Most service providers operate with separate prepaid and postpaid systems, typified by disparate technology platforms and business processes.

Figure 17: Prepaid and postpaid markets



Source: HP, 2006

Looking to the figure 17 (prepaid markets section) we realize that operators will increasingly fight to steal each other high end users. At the same time, the growing number of low-usage subscribers will have a negative impact on Average Revenue per Subscriber (HP, 2006). On the other hand (postpaid markets section) the operators will fight for the heavy users. Heavy users are the most profitable for any operators and they are receptive to new technologies and services.

Attending to the mobile market, today prepaid accounts number more than half of wireless subscribers globally and will continue to drive growth in the market. At the same time, postpaid accounts represent a higher ARPU and this market has peaked the attention of service providers. Right now operators are delivering most of their marketing offers in the post-paid mode. When they want to promote new products in pre-paid, they find themselves blocked by the systems currently in operation. The systems are simply not flexible enough to

integrate services such as downloads, roaming, LBS (Location Based Services) or bundled services (Mocchi, 2006).

There's been a huge gap between the two worlds from the very start. The two systems require different teams, even within the same company. Traditionally, telecom operator IT services have always handled post-paid. They calculate the costs and bill according to the network data collected by mediation solutions. In the case of pre-paid, the transaction management software is directly integrated in the network infrastructure, so it is the network specialists who set the rates (O'Reilly, 2006).

According to the same author, it's crucial that operators develop their pre-paid payment systems, because pre-paid customers are, for the most part, young and early adopters, and these demographics constitute a strong target market for new added-value mobile data services: music and ring tone downloads, and localized content, for instance. As the financial status of this population is still insecure, operators may want to keep these customers on pre-paid, while still developing a system capable of delivering these new services.

Nowadays, this separate vision of these two traditional approaches is changing and the two markets are converging, leaving mobile providers with a technology challenge and a business opportunity. The answer is a business support system that is technically capable of mixing pricing schemes, billing accurately, and delivering a cost-effective infrastructure that maintains the quality and capacity customers demand (HP, 2006).

This convergence makes it easier for customers to migrate from pre-paid to post-paid. Besides that, it's also a valuable tool for increasing the per household penetration rate. For example, "Imagine a family where the parents are on post-paid and the children on pre-paid. If the payment modes are consolidated, content and services could be billed to the same account, but at different rates, depending on whether the user has unlimited access or not" (Mocchi, 2006).

The billing engine is another key point for understanding the Telcos strengths in the rich voice market. One of the crucial applications that Telcos and MNOs in particular have installed on their networks are billing systems. They are able to bill per second of voice or video call, per message or per kilobyte of data, or for any other transaction. Associated with billing are the security and authentication systems that make it secure and trustworthy. This capability can be offered as a service to subscribers and content companies.

"We have the capability to bill, invoice the customer, and it's up to a third party – we are not the creators of all the content, we understand that the clever people is outside and if they are clever enough and they want to be reached we have a billing machine, an access network that allow them to sell their product" (Telefonica Mobile, 2003).

Mobile network operators also have the capacity to bill individual terminal users, rather than households or companies that have fixed lines.

"The mobile operator has a big advantage over the fixed operator because now the world is talking about billing everywhere. Fixed operators normally bill a home or an

enterprise, doesn't bill an employee or a person. We have the billing engine capable to bill senior persons" (Telefonica Mobile, 2003).

Rather than having just one way of billing, this sophisticated billing system allows operators to package "service products" to bill for any unit: a piece of information, a photograph, a phone call, irrespective of any actual costs to deliver, or relative the cost of another service product.

Billing systems are important for convergence networks and for convergence terminals, because they potentially allow the use of many different wireless access systems into one bill for the end user. Today, Nokia is promoting a system that allows firms to use the same billing system by using the subscriber's SIM as identification for both Voice and WiFi networks. *T-mobile* in the USA is offering an integrated billing system for their cellular and public WiFi hotspot customers (Meyer, 2006).

Telecom operators attempt to create value added services on top of basic services. The telecom operators are looking for new values; new services that make the customer to spend more money. For a telecom operator the basic service is voice and then they can add new services that can be either voice or data. In a last instance, a service means anything that can be offered and billed to the end customer (Stewart, 2003).

"You can go all this in voice and you can imagine whatever, conference calls, automatic assisted information doing a calling conversation where you can imagine is the future we are looking for enriching the person to person voice communication. Then it comes the paradigm of writing, messaging and this is the most successful second key application for mobility right now and the position is very clear". (Telefonica Mobile, 2003).

Nowadays, communications service providers (CSPs) face a number of significant risks to their operations. Among these are:

- Commoditization of services – Traditional voice services are becoming increasingly commoditized. As this trend drives prices down, it subsequently puts CSPs under cost pressure. CSPs run the risk of losing their competitive advantage if they do not substantially improve their cost economics;
- Market saturation – CSPs enjoyed significant growth rates in the past, mainly driven by mobile subscriber growth. Now those markets are saturated, particularly in the developed economies. CSPs need to find other ways to re-ignite the growth engine. Otherwise, they face the risk of diminishing earnings before interest, taxes, depreciation and amortization (EBITDA) caused by declining prices putting pressure on margins (Chevins, 2006);
- New entrants – CSPs are facing intensified competitive pressure from new entrants into the market place. Media and retail firms are launching mobile virtual network operators (MVNOs). Cable companies are entering the telecommunications market offering triple play: voice, video and data – driving CSPs to expand their global EBITDA footprint by

acquiring or building subsidiaries outside their homeland in order to sustain growth, build on economies of scale and improve brand image (Chevins, 2006);

- **Convergence** – Convergence has become a reality and CSPs are preparing for fixed mobile convergence (FMC) and will launch innovative service bundles. Cable companies are offering triple play and CSPs have responded to this competition with IPTV services and mobile data services;
- **Customer experience** – In a world where traditional voice services are commoditizing and customers have an increase in service provider choice, as indicated by high churn rates, creating a superior customer experience is the key to differentiation and achieving customer loyalty. Unless a CSP is able to provide that differentiated customer experience, it runs the risk of a shrinking customer base and facing a low-value commodity business model in which customer attraction and retention is controlled by the handset subsidies.

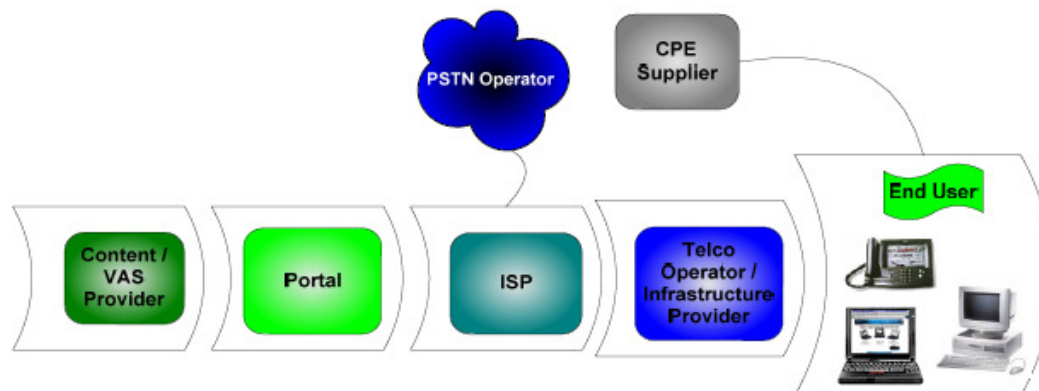
3.4 Current Value Chains and Business Models

3.4.1 The Internet Value Chain and the Open Service Model

The open service model is the service model used in the Internet, where each stakeholder is usually a different organization. The application, the access device (e.g., PC, laptop, mobile phones, VoIP terminal), and service content may each be controlled by a different entity, and the service provider is typically viewed as only a “bit pipe” relayed by a typical telco operator.

The user has access to all services available in and beyond the service provider. Access to all available 3rd party services and content, is allowed, usually without paying more than a flat monthly fee to the service provider. More than a single protocol or application should be used to browse content or to have access to services from different sources. A single content provider or a portal operator aggregating contents or services may own customer relationship.

In the Internet model, interoperability of protocols and services is not assured. Other implications related to access, such as security, are also an open point. The most common use of the open model is the Internet Service Provider, where the service is usually nothing more than Internet access (as previously mentioned, there is a trend for ISPs to consolidate their business with their parent companies (PSTN operators), or wireless business units, thus transforming into Wireless ISPs (WISPs). The figure 18 depicts this value chain.

Figure 18: The original Internet value chain

Source: Daidalos consortium, 2006

The *Center for Research in Electronic Commerce* (CREC) at the University of Texas produced a series of indicators of the Internet economy. The CREC divided the Internet economy into four layers:

- Internet infrastructure – including telecommunications companies, Internet backbone providers, Internet Service Providers (ISPs) and other last-mile access providers, as well as manufactures of CPE;
- Internet applications infrastructure – mainly, software required for Internet services, but also consulting and service companies hired to build web services;
- Internet intermediary – economic activity at the intermediary level includes service provided by auction and aggregation providers; companies that package or provide a forum for economic activity, though they may not be involved in the activity itself;
- Internet commerce – finally, the commerce layer includes companies that are engaged in sales and transactions over the Internet.

There are three sources of revenue for Internet Service Providers that show the most promise for sustaining the development of the sector: user-supported services, advertising revenues and transactions (O'Donnell, 2002). To varying degrees, all the Internet business models rely on one or more of these three categories of revenues. The expectation of many early adopters of the Internet that all content should be free was a driver of, and a response to, the heavy emphasis on advertising revenue in many early web site business plans.

As we shall see, the early Internet advertising market was not capable of supporting all of the businesses expecting to cover expenses through advertising (Ries, 2002). The failure of conventional “measured” advertising, that is, advertising sold on a per-view basis, in which larger audiences would fetch proportionally higher advertising fees, does not mean that advertising is not viable as a long run component of Internet business revenues. The early Internet markets was dogged by high overhead for the small audiences reached, and the non-linear pricing of most advertising, in which larger audiences attract a higher, per-viewer price than smaller audiences, meant that the highly fragmented Internet advertising market was condemned to very low rates. To make matters worse, advertisers raised questions about the

effectiveness of Internet advertising, though, unfairly, the same question is rarely raised about advertising in other media.

User-supported service revenues for the Internet include monthly Internet access fees and fees for services or content delivered over the Internet. For the services and goods categories, user-supported revenues include both subscription and “pay-per-view” or “pay-per-download” payments.

Finally, revenues from transactions may accrue to retailers selling on the web or to intermediaries who are compensated for referrals or through affiliate programs. In either case, it is necessary to distinguish between the value of goods and services sold over the Internet and the amount of the proceeds from sales that go to support the Internet infrastructure.

3.4.2 The Mobile Browsing Value Chain and Business Models

The mobile telecommunications industry is for the time being characterised by a lack of licenses, high investments in network building and deregulation of old monopolies. There is an increased complexity both in the market and in the industry, and there is a search for new business models for expansion.

The mobile market is still a very attractive market with many players that want to get a slice of the pie. Each country has a limited numbers of available frequencies, and, therefore, can only award a limited number of licenses. As there are a lot of players that want to be mobile operators and only a few of them are able to get a license, because of the limited number of licenses and the huge cost of building a mobile network, new type of players, Mobile Virtual Network Operators (MVNOs), have emerged. The regulators have welcomed the new players because they want to enhance competition for the benefit of the users.

An MVNO is a new business model, and faces several challenges, such as the obviously asymmetric agreement with an MNO. The strategic position for an MVNO will depend on the origin of the company. Possible origins are divided into three groups: retailers, expanders and integrators. Each position has different strategic options and possible strategic advantages. Rather than defining the MVNO as one new role, it makes sense to view the MVNO as a collection of roles. An MVNO could in principle undertake any role, but by definition it must, from a customer perspective, appear to be an MNO, having the same interfaces towards the customer as an MNO. In addition, the MVNO cannot hold its own licensed radio spectrum.

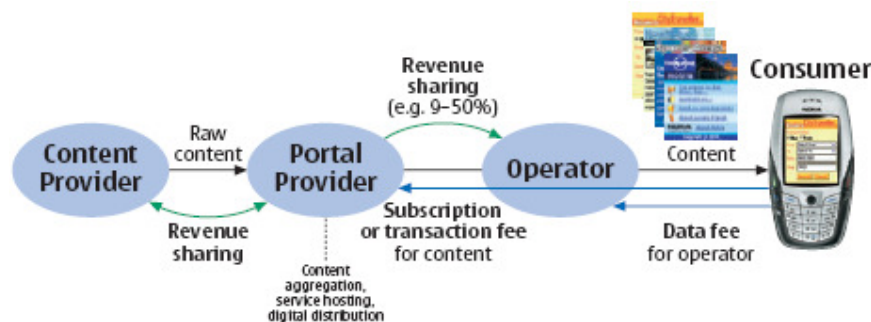
The question for an MVNO is how “deep” (with customer facing being the highest level, and radio access provisioning being the lowest) into the value system it should go. The MVNO has to consider which facilities to own and run, which to outsource and which to lease from the MNO and what type of agreements it should seek with partners in order to appear as an attractive choice to the customers (Lillehagen, 2001).

MVNOs could be another supporter of Open Source. Typically, MVNOs purchase bandwidth from traditional network operators and retail their niche, branded service to consumers. It is in the interest of MVNOs to support other forms of connectivity because

they usually pay to the network carrier on a per transaction or megabyte basis. Providing an Open Source, highly customizable phone to technology savvy customers might be a significant market segment in itself. A more radical, yet less likely possibility is a completely open mobile phone stack. There is a conceivable business model around distributing low-cost handsets with Open Source software and making profits on the application services, for example, focusing on niche markets like entertainment or dual model handsets (WiFi and GSM).

The mobile browsing value chain (Figure 19) can typically be split into four parts: consumer, network operator, service provider (e.g., mobile portal) and content provider, with the key being service discovery and billing.

Figure 19: Example of the mobile browsing value chain



Source: Nokia, 2003

Here is a short explanation about the roles of the main actors in the browsing value chain:

- **Consumer** – The ultimate source of all revenue in this model. He/she is the direct source of data fees, monthly subscription fees and premium service fees;
- **Operator** – Delivers mobile web content from the content providers to user terminals. Manages user billing and delivers value-added services to content providers, such as authentication, location and push;
- **Portal provider** – An optional 3rd party managing the aggregation of service content, business and technical relationships with content providers, and packaging and marketing of services for end user segments. This may be a function of the operator, probably forming a separate division from provisioning and delivery;
- **Content provider** – A creator of a mobile web-based service or web site. May provide actual content such as infotainment, downloadable content, or other web-based data, or may provide person-to-person services such as e-mail or chat;
- **Mobile search engine** – Although this role has not yet been successfully filled, the open mobile Internet depends on an effective service for discovering useful mobile content on the open web.

Mobile browsing increases data traffic in operators networks, generating more revenue. Data traffic revenue is of special interest for operators, as revenue from content is often shared with content providers.

There are three fundamental business models for browsing: walled garden, open garden and ISP – Open Mobile Internet.

The walled garden model provides organized, uniform access, through a mobile portal, to high quality services designed for mobiles. *Nokia company* considers that a mobile portal must be more like the TV business than any other, constantly tuning the offering to keep ratings (i.e., usage) high. Traffic is built by offering users good value through a competitive set of bundled services for a fixed monthly fee, plus optional high-value premium services for an additional fee.

In an open garden model, the operator provides high quality, well-organized, and eventually personalized content and services within the portal, as in the walled garden model. Users are also free to access open mobile web content as in the open Internet model. A mobile portal provides organized links to high quality mobile web sites, but also allows the user to search the whole web. The open mobile garden is most efficient in partnership with a mobile search engine, with a way to adapt or filter results based on suitability for the target device (Nokia, 2003).

Standard Internet Service Providers (ISPs) simply provide connectivity, usually with several value-added services such as e-mail accounts, web hosting space, and possibly private domain hosting. As more desirable mobile content becomes available outside the operator's portals, mobile search takes a more significant role. This in turn presents possibilities for advertising.

The revenue models within these business models are the following:

- Traffic = revenue – As long as the above remains true, then increasing traffic is the surest way to increase revenue. Operator provides services, licensed services, outsourced portal services and open Internet services. All of these generate data revenue;
- Growing 3rd party mobile services – The business model should support the investment a content provider has made in creating mobile services. The cost of developing a mobile web site must be offset by sufficient revenue to provide a satisfactory ROI;
- Up-front license fee – One way to pay for content development is for the operator to pay up front, either a development fee or fixed licensing fees. This puts most of the risk on the operator's side, since an unsuccessful service will still cost the full amount. The limited risk for the developer should encourage content providers to build services;
- Shared data revenue – The license payments should be tied to generated traffic to create a win-win situation for both the operator and content provider. This amounts to sharing data fees, the operator makes data revenue from increased traffic, and pays the content developer more based on the traffic they generate. This encourages the content provider to be creative, looking for a big "hit", which benefits both. It also limits the risk for the operator, as the cost of failure is also borne by both parties;
- User monthly subscription fee for bundled services – Many operators charge a monthly service fee for mobile data services. This provides a guaranteed revenue stream from

current subscribers, and can help finance development of a mobile portal and its services. Users are also encouraged to use the mobile browser services they have paid for, rather than waste that investment. This can drive traffic, helping to fuel the “virtuous cycle”. However, an up-front fee is also a barrier to entry for many users, who do not yet see any value from mobile browsing and so are unlikely to pay in advance. The alternative strategy is to open mobile browsing access for all customers, and provide services so enticing that users quickly become accustomed to using their mobile browser, and begin increasing their ARPU by adding data traffic on top of voice services;

- Portal provider fee – If the operator outsources the creation, management and maintenance of a mobile portal, he will need to pay the portal provider various fees; these include service, as well as billing for partner sites and possible sharing of data revenues based on traffic;
- Placement fee – A successful mobile portal becomes a valuable source of “eyeballs” – mobile user traffic. Commerce, service and other sites that want to extend their reach will be willing to pay the operator or portal provider for placement in the portal. Search engines and directories also charge for placement in relevant search results and directory categories. This is a significant source of revenue, enough to make the best search engines highly profitable and encouraging large “mega-portals” that aggregate as many users as possible, perhaps across a large operator’s subsidiaries, or a portal provider supporting a number of operator customers.

3.4.3 The Mobile Broadcast Value Chain

Broadcasting is historically one of the oldest value delivery mechanisms in telecommunications. In the broadcasting world, network costs have been in principle supported by the providers of content (commercial content suppliers, radio/TV producers), except pay-TV where, like in the world mobile, users support the cost of the network.

Mobile broadcasting can generate revenues from three sources, namely from:

- Customers;
- Advertising;
- Broadcast network access fees.

Customer revenues are based on the additional value of mobile TV services. Different charging mechanisms may be used. A monthly subscription fee is considered the most acceptable according to nearly all pilot market research. But pay-per-view or time-based charging are other options. Additional customer revenues can be generated by interactive services related to broadcast services. The charging models then are based on the models applicable to the kind of interactive service used. For SMS-based voting the well-established premium SMS charging can be used. Pointing to the Internet, well-established Internet charging mechanisms can be adopted.

Mobile broadcasting provides a new distribution channel for TV content including advertising. Thus, selling air time to advertisers can be considered as an additional income source for broadcasters. New potentials for advertising may be opened up to combining broadcast ads with personalised advertising features using the interactive channel. Advertising revenues probably will become significant only at a later point in time when mobile TV service has achieved sufficient penetration.

Broadcast network access revenues may be based on the potential interest in securing access to the mobile broadcast network in order to participate in the emerging market. One aspect which may generate infrastructure access revenue lies in the valuable extension of coverage, not only related to the area or population but also to the time of day at which users can be reached.

In most of the studies on mobile broadcast business models (Sattler, 2006), the following main roles of the value chain have been identified:

- Broadcaster – aggregating content into channels based on a broadcast licence, if necessary;
- Mobile broadcast service provider – providing the mobile broadcast service based on a platform license, if necessary;
- Mobile network operator – operating the mobile network and mobile services;
- Broadcast network operator – operating the broadcast network based on a frequency license;
- Users.

The role of the mobile broadcast service provider is taken here to define a service consisting of channels broadcasted for mobile reception. It is a new role in mobile broadcast business and one which did not exist in the classical mobile and broadcast business so far. To some extent it can be compared to a cable operator, packaging channels and other packets as well.

Players in the value chain can take on one or more roles (Sattler, 2006), e.g.:

- In Italy, *Mediaset* is in the role of the broadcaster as well as the broadcast network operator;
- In the Netherlands, *KPN* is in the role of the MNO and (via *Nozema*) also related to the broadcast network operator. The same is true of Hutchison 3 Italy owning frequency license;
- *T-Systems* in Germany as well as *TDF* in France and (via *Digita*) in Finland are broadcast network operators not related to any broadcaster.

In the literature and in practice, a large number of different approaches to describe mobile TV business models can be found, differing in abstraction level or type of value chain presentation.

Under the service selling and billing aspect, there are two generic business model approaches based on the customer ownerships from other business:

1. (Pay TV) broadcaster-led model;
2. Mobile network operator-led model.

Under the mobile broadcast service provision aspect, several players will be able to handle this role:

- Broadcaster;
- Mobile network operator;
- Broadcast network operator;
- Third party.

If he does not own the customer relationship, the mobile broadcast service provider will need to define a wholesale service to one of the customer owners. This leads to another model:

3. Wholesale model.

In the following, these three models will be described in more detail.

The broadcaster-led model

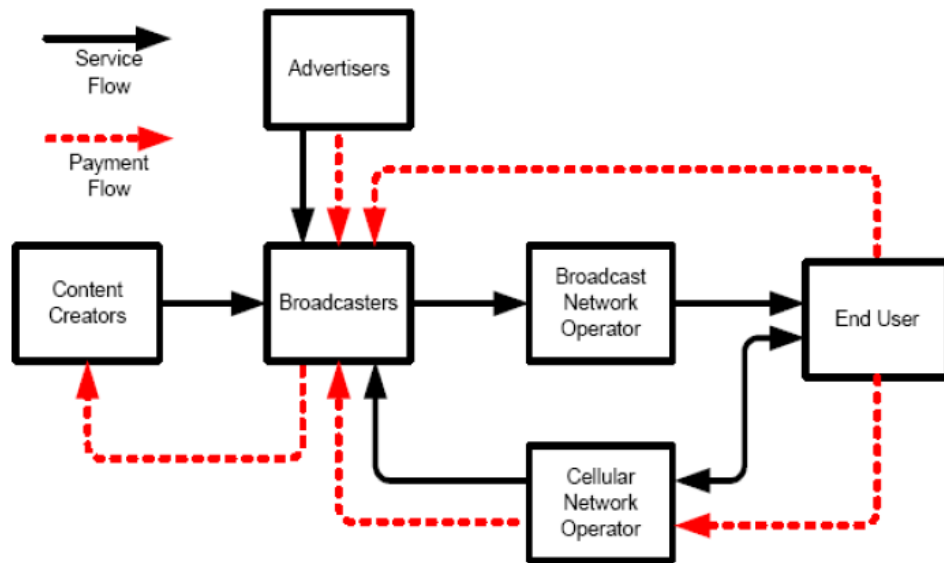
In the broadcaster-led model, a (Pay TV) broadcaster handles the role of mobile broadcast service provider, manages the end-relationship with the customers and is responsible for service provision, marketing and customer care.

Normally, a broadcasting company will package its own channels alone and provide them to their pay-TV customers. As this is not an integrated service proposal, consumers may need to subscribe and pay to more than one service provider to obtain the different services.

The broadcaster receives payments for the use of service from consumer subscriptions, or through payments made via the mobile network operator. A variation on this could be broadcast funding from advertising revenue. The broadcaster will be able to offer the mobile broadcast service in a package with its stationary pay TV service.

Fully interactive services are a possibility, but they will make necessary a separate billing procedure. As an alternative, the broadcaster could obtain the status of a mobile virtual network operator (MVNO).

The involvement of the mobile network operator may be limited except for linked telecom services.

Figure 20: Broadcaster led model

Source: Sattler, 2006

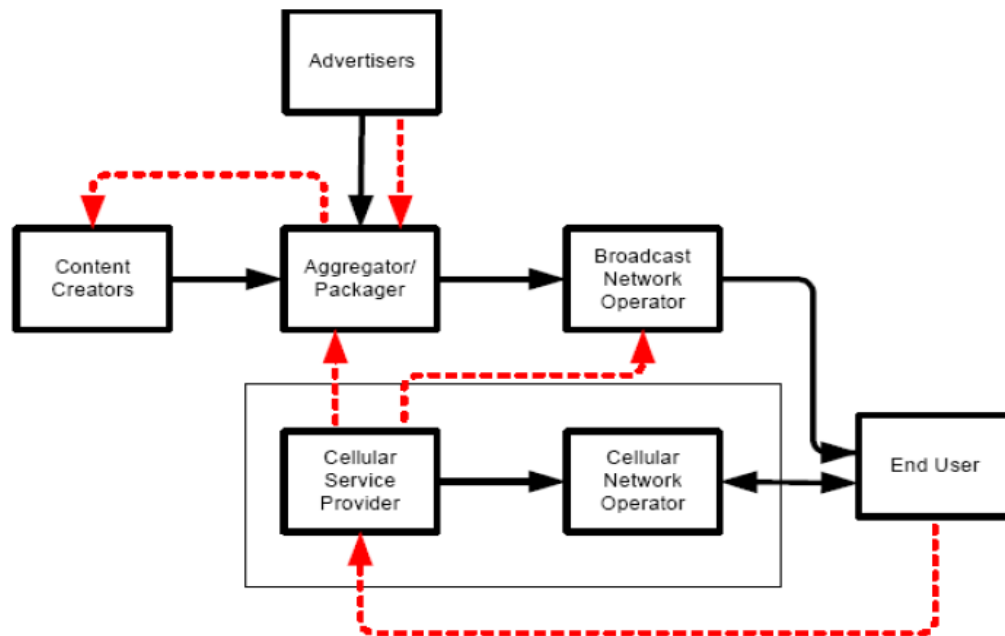
In this model, the broadcaster will need to enter into an agreement with the mobile network operator regarding the device technology, unless the former limits him to selling devices unconnected to the mobile network. Given the expected initial high cost of mobile broadcast receivers, market penetration may remain low if no receiver subsidies are offered.

The commercial risk is the broadcaster as the mobile broadcast service provider. He has to pay the broadcaster network operator for the network set-up and operation, unless he also takes in this role.

Mobile network operator-led model

In the mobile network operator-led model, the mobile network operator handles the role of mobile broadcast service provider, manages the end-relationship with customers and is responsible for service provision, marketing and customer care.

For the service, the mobile network operator will need to purchase content from broadcasters and other content providers. In particular, he will become himself a broadcaster establishing his own channels, acquiring a broadcast license, if necessary.

Figure 21: Mobile network operator-led model

Source: Sattler, 2006

Customers will have access to an integrated service proposition, which means that a complete package will be offered by the mobile network operator. The mobile network operator will receive payments for the use of mobile broadcast service from consumer subscriptions.

Fully interactive services are a possibility and no separate billing procedure will be necessary for consumers to pay for the use of such service. As a variation, the mobile network operator could directly handle advertisements. While mobile network operator would be responsible for general marketing, it could be possible for broadcasters to market individual television channels. For channels that generate revenues (e.g.: Televoting), broadcasters would be responsible for marketing the channel while the mobile network operator would be responsible for billing.

The mobile network operator will have full control over the mobile device. He is also in a position to subsidise the device and to offer the mobile broadcast service in a package with other mobile services.

The commercial risk is with the mobile network operator as he is the mobile broadcast service provider. He will need to pay the broadcast network operator for the network set-up and operation unless he takes on this role himself, but possibly also to the broadcasters for providing the channels.

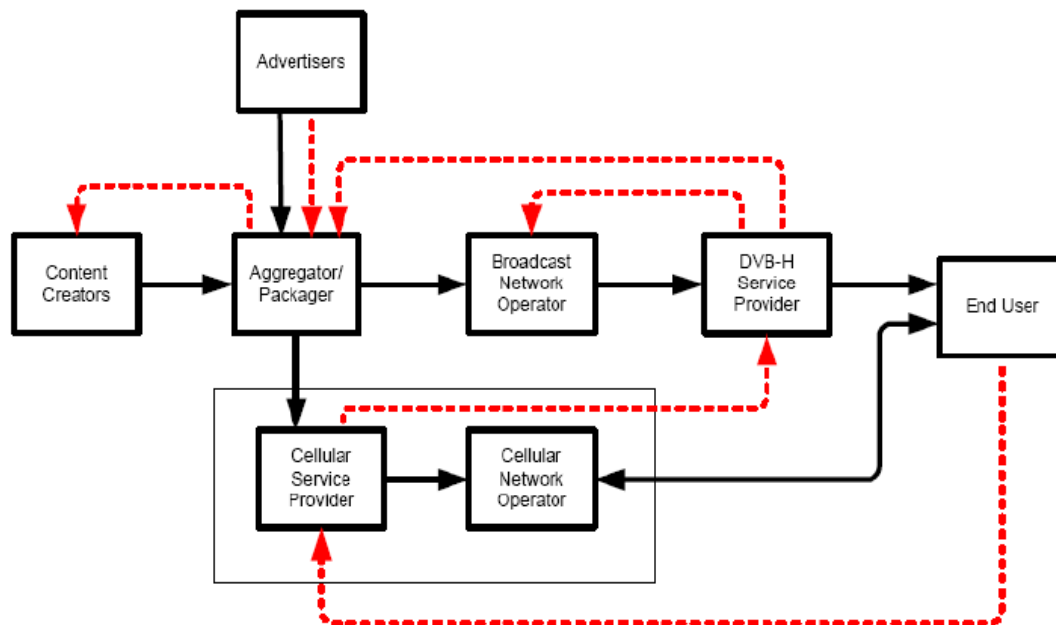
In any geographical area, there will normally be more than one mobile network operator. This model implies that each of the mobile network operators will broadcast his own package, even if the same channels are also available in the package of another mobile network operator. The inefficient usage of frequencies can only be overcome through the wholesale model.

Wholesale model

In the wholesale model, a dedicated mobile broadcast service provider (wholesaler) acts as a facilitator for mobile network operators in the aggregation of channels and the usage of broadcast transmission capacity. For the service, the wholesale will need to purchase content from broadcasters and other content providers, among them also the mobile network operators. In particular, he may become himself a broadcaster establishing his own channels, acquiring on a broadcast license, if necessary.

Customers of each of the mobile network operators will have access to an integrated service proposition, which means that each will offer a complete package. The package and the service offer of the mobile network operators may differ in some parts (e.g., in bundling them with other services in different manners).

Figure 22: Wholesale model



Source: Sattler, 2006

The wholesale receives payments from the mobile network operators who in turn will bill their customers for the service.

The wholesaler could promote market penetration through image marketing. The mobile network operators will have full control over the mobile device. They are also able to subsidise the device and to offer their mobile broadcast services in packages with other services. The wholesaler needs to set the standards for the wholesale service including broadcast reception and purchase and protection.

The commercial risk is with the wholesaler being the mobile broadcast service provider. He needs to pay to the broadcast network operator for the network set-up and operation unless he also takes on this role, but conceivably also to the broadcasters for providing the channels. Having the commercial risk, on the other hand the wholesaler is in the position widely (limited maybe by regulation or license terms) to define the channels to be broadcasted.

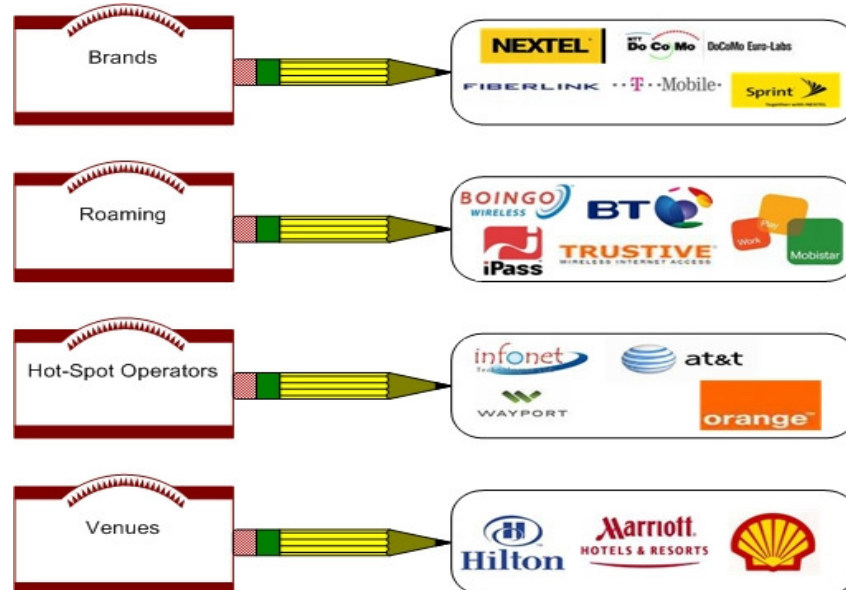
However, he needs to consider the interests of the mobile network operators selling the channels to their customers.

3.4.4 The Hot-Spot Industry Value Chain

The commercial success of the WiFi technology, and its deployment in wireless hot-spots has introduced a business segmentation which is taking shape in four layers. At the bottom of the stack, the venue layer consists of the companies that own the physical locations where hot spots will be deployed (location owners). Companies in the hot-spot operators (HSO) layer, contract with venues to deploy WiFi gear and operate commercial hot spots. Because of the inherent fragmentation of hot-spots, HSOs will partner with companies on the aggregation layer to provide roaming, software and settlement services and drive traffic to their networks. Aggregators in turn enable the brand layer companies to offer WiFi access to end users.

The figure 23 depicts a generic value chain of the hot spot industry with a small sampling of roles residing at each layer.

Figure 23: Hot-Spot industry segmentation



Source: Boingo, 2003

Venue layer

One of the primary factors contributing to hot spot fragmentation is the inherent fragmentation at the venue layer. Put simply, there are a huge number of locations owned by a huge number of different entities. Even *McDonald's*, the world's largest restaurant chain, has a relatively small share of the world restaurant market.

If we were to compare to the cellular industry, venues would be the equivalent of spectrum licenses – the right to deploy a wireless service in a given area. However, in cellular, there are

as many licenses as there are cafes, bars, restaurants, retail stores, airports, gas stations, parks, hotels and scrappy entrepreneurs.

Venue owners make money in WiFi by both vertically integrating and operating their own hot spots, or more commonly by licensing the right to deploy hot spots to an HSO. In general, if the HSO pays for 100% of the cost of deploying and managing the hot spot infrastructure, they will share very little or none of the revenue with the venue owner, at least until the HSO's costs are recouped. The more of the up-front costs paid by the venue owner, the higher their revenue participation (Boingo, 2003).

However, many venue owners are more interested in providing a hot spot as an amenity and convenience to their customers than in generating direct revenue. Operators of airports, hotels and cafes are quickly realizing that not providing a hot spot in their venues will soon mean lost revenues and even lost customers (Boingo, 2003).

Hot spot operators layer

As noted earlier, the entry barrier to become a hot spot is low, the range of WiFi networks is short and there are nearly two million existing public venues in the US (Boingo, 2003). This leads to fragmentation at the hot spot operators layer. Anyone with a \$500 hot-spot in a box, a DSL line and an "in" with the owner of a small café chain can become an HSO (Boingo, 2003).

Ultimately, there will be thousands of HSOs, dozens of which will become very large. However, even with significant capital to spend on deployment, the fragmenting forces inherent in WiFi mean that ultimately no provider will own more than 10% of the total hot spot footprint (Boingo, 2003).

HSO success is determined by operating the lowest cost networks with the highest network utilization. An HSO's monthly per location costs are mostly fixed: depreciation of equipment, hot spot maintenance and back-haul costs for a DSL line or T1. Once there's enough traffic to overcome these fixed costs, all additional revenue is margin. Thus, it becomes essential to sign as many partners as possible to drive demand to the hot spot.

Overcoming fragmentation and driving demand is where the roaming layer comes in.

Roaming layer

Roaming providers, such as Boingo, strike wholesale access agreements with HSOs and aggregate their hot spots into a single seamless network. They turn around and provide a single network to brands, along with software, technical support and back-office services.

In some cases, brands will have direct relationships with larger HSOs to gain access to their hot spots. However, they will still need a roaming provider to tie those hot spots together into a single network along with thousands of smaller HSOs that the brand is unlikely to want to deal with.

The brand charges their end user and pays roaming provider fees for networking aggregation, settlement, support and client software. The roaming provider in turn settles with each HSO, paying a wholesale connect fee for each of the brand's user connections.

After the industry shakeout, there are likely to be only one or two major roaming providers. There is immense complexity in negotiating with and aggregating thousands of individual HSO's, providing systems to manage authentication, network management and reporting.

In addition, to avoid multiple integrations, HSOs are unlikely to want to work with more than one roaming provider, especially if that roaming provider already has partnerships with many brands representing millions of potential users. Likewise, it is operationally infeasible for a brand to work with more than one roaming provider, since aggregating roaming providers would defeat the purpose of working with one in the first place.

Roaming providers like Boingo will drive significant traffic to hot spot operators, helping them cross the line of fixed costs into the territory where incremental revenue is highly profitable (Boingo, 2003). Roaming providers serve as the vital link between individual hot spot operators and the major brands that will drive the mass market into their locations.

Brands layer

Brands include wireless and wireline carriers, ISPs, cable companies, PC manufacturers and enterprise remote access providers – anyone seeking to offer a branded Wi-Fi hot spot service to their customers.

As with anything, there are no absolutes, and some companies will cross the segmentation lines, possibly occupying multiple layers at once. However, as competition heats up, the most successful players will be the ones most focused and who can get economies of scale within a layer. For a company with a multi-layer approach, this may mean running each layer as though it were an independent entity.

For example, several large cellular carriers are now deploying commercial hot spots, at the hot spot operator layer, and are launching branded Wi-Fi services, at the brands layer (Boingo, 2003). Certainly, they have the capital and expertise to deploy networks, and they have relationships with millions of existing customers to whom they can promote a Wi-Fi hot spot service.

However, unlike cellular where there was a limit on competition, the fragmentation of Wi-Fi makes it impractical to build a single exclusive network and then sell exclusively to one's own end users. If a carrier were to deploy hot spots at three or even thirty airports, that footprint alone would not make a successful service. There is a little overlap between the venues a carrier can deploy in and the coverage that its customers will demand. Roaming is essential to a viable service (Boingo, 2003).

At the same time, if a hot spot were to prevent other brands' customers from roaming onto its network (for a fee), it would be under-optimized its fixed costs. Moreover, venues are increasingly demanding that their HSO allow access by multiple brands, so as not to hold the venue's customers captive to the HSO's own "house" brand. This is especially true at airports such as San Francisco International Airport (SFO), Dallas-Fort Worth International Airport (DFW) and others, which look for a single neutral provider to build and operate hot spots. Even without such a requirement, hot spot profitability is inevitably determined by utilization, which means opening up the network for as many brands as possible to drive demand.

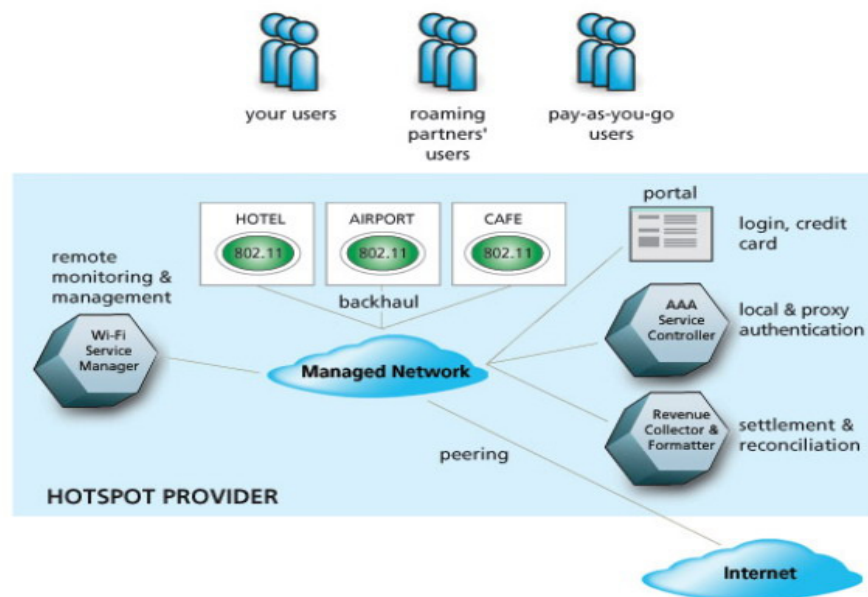
Thus, a roaming provider is essential to brands, both to provide coverage and to drive additional demand to their own hot spots.

To establish a good market for WiFi, there must be a well-established market model, where its players (and the relations with them) are well-defined.

WLAN Hotspot Provider

WLAN hotspot providers are deploying hotspots at premium public venues to take advantage of the increasing subscriber demands for the high-speed access.

Figure 24: Market model of WLAN hotspot provider business model



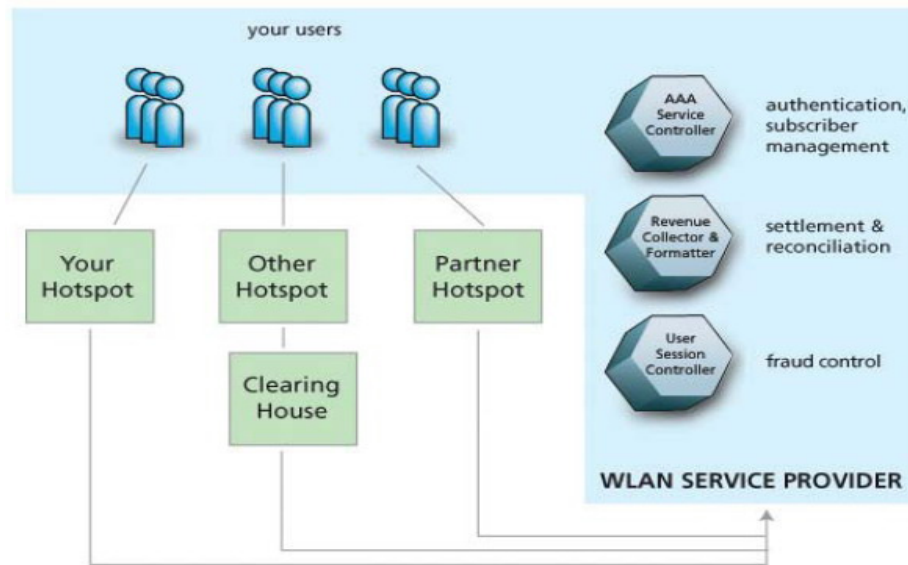
Source: TTD, 2003

The Hotspot service provider does the following:

- Set up a network of hotspots for geographical or vertical coverage;
- Develop profit-sharing agreements with venue owners;
- Exploit existing copper or coax to optimize backhaul costs, or share the venue's facilities;
- Ensure on capitalizing revenue opportunities from pay-as-you-go users, new value-added services;
- Invest in remote monitoring & management capabilities to provide strong cost savings.

WLAN Service Provider

WLAN service provider offers WLAN access as an add-on service for the existing subscribers and to attract new subscribers. It also creates a satisfactory coverage area, by signing roaming agreements with WLAN hotspot providers and clearinghouses.

Figure 25: Market model of WLAN service provider business model

Source: TTD, 2003

WLAN service provider can do the following:

- Creating hot-spot roaming services for their direct subscribers;
- Creating vertical market offerings to appeal to direct subscribers, such as café hot spots, hotel hot spots, and so on;
- Creating or increasing geographic coverage in strategic markets;
- Authorizing users based on strong policies, passing these policies in real time to the roaming partners in order to establish the subscriber's service and entitlements;
- Tracking usage to support a variety of billing models, including minutes of use, megabytes of data, pay-per-view and so on;
- Aggregating all usage related to a single WiFi session – including bytes, time and chargeable resources – into a single session record, which makes it easier for billing systems to translate into a single line item on the user's bill. And eventually, aggregate usage records for a session that roams across a variety of access technologies such as 802.11, CDMA plus GPRS services.

Like service providers, hot spot aggregators connect WiFi users to the network, and tend to offer monthly or hourly subscription services direct to subscribers. In some cases, these aggregators will own the hot spots, and in others, they will have roaming agreements with hot spot facility providers, and offer their service either at the wholesale or retail level.

What may differentiate hot spot aggregators is that some of them tend to offer their services around a theme or specific vertical market, such as an aggregator that offers hot spot access at hotels, one that offers access at cafés, or one that offers services at a variety of airports.

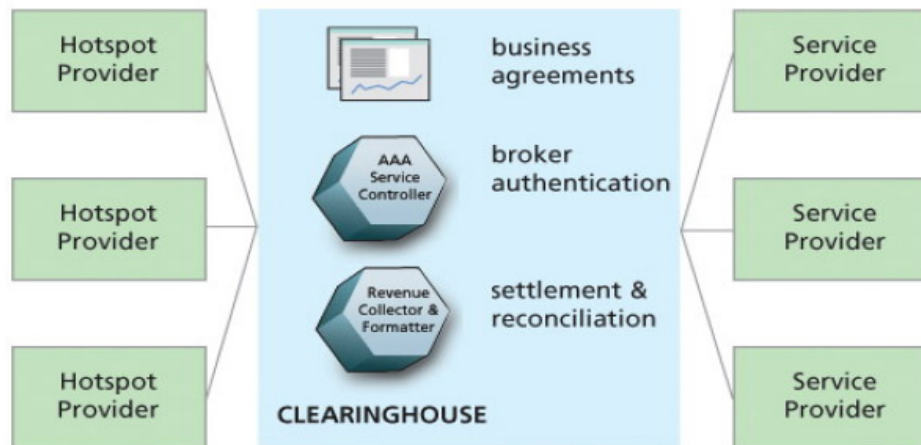
WLAN Clearinghouse

A clearinghouse focuses on brokering relationships, and in particular roaming agreements, between WLAN hotspot providers and WLAN service providers. It does the following:

- Offer mediation, settlement and reconciliation functions to calculate and validate payments between service providers and hotspot providers;
- Provide comprehensive reports to these providers;
- Broker supplementary service requests;
- Provide authentication and mediation for roaming between hotspot networks and 3G networks;
- The revenue will likely be calculated as a percentage of this revenue flow.

Clearinghouses may also provide settlement and network management services, but have neither wireless facilities nor subscribers.

Figure 26: Market model of WLAN clearinghouse business model



Source: TTD, 2003

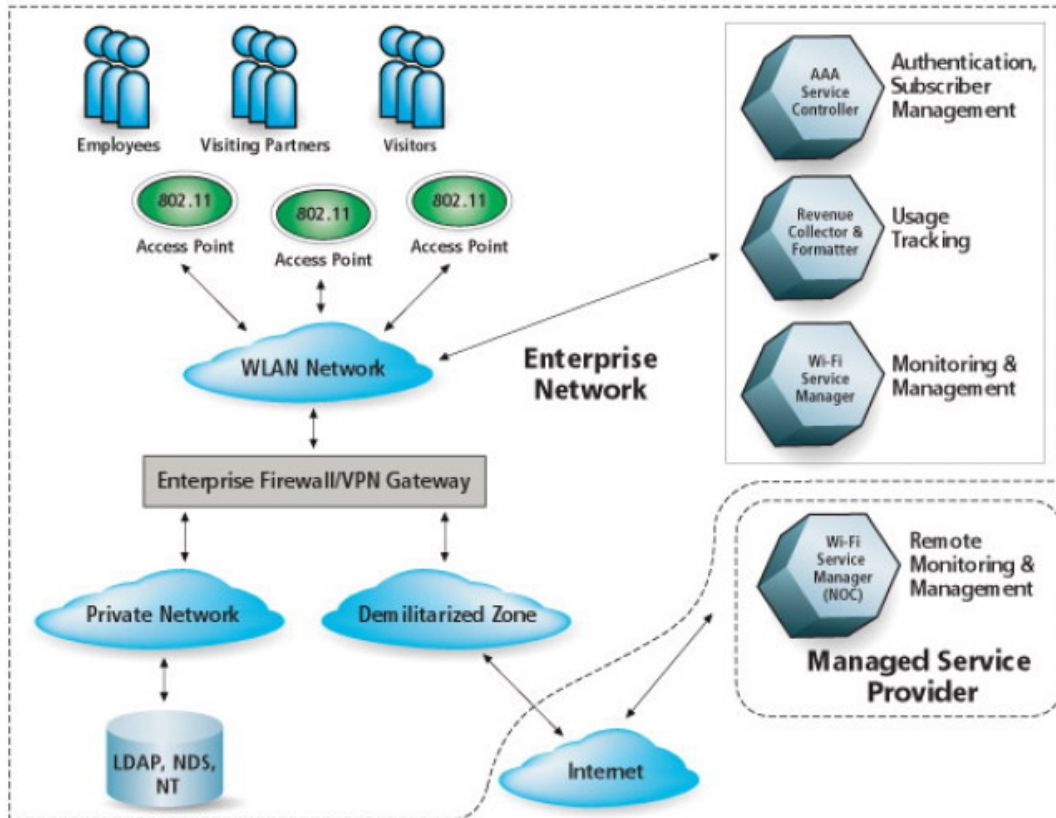
Managed WLAN Service Provider

Many enterprises will opt for 802.11 as a managed service, opening up opportunities for carriers to act as the managed WLAN service provider. Enterprise-wide WLAN deployments can be quite complex. Enterprise IT departments may, simply, not have the time or expertise to deal with issues such as proper antenna placement, channel selection and security. This creates an opportunity for carriers to bundle WLAN managed services with their existing connectivity services, particularly since many carriers already have customer promises equipment (CPE) in place.

As a provider of managed WLAN service, his focus is on the enterprise, installing and managing WLANs for organizations. As part of his service, he manages authentication and access services, allowing enterprise employees to reach the enterprise's private network.

One can also operate the managed WLAN as a hotspot, allowing visiting business partners such as customers or suppliers to reach the Internet or tunnel to their home network, through the enterprise WLAN.

Figure 27: Market model of managed WLAN service provider business model



Source: TTD,, 2003

3.5 Emergent Business Models

The actual business models are under pressure and they should be reconfigured to take account the evolution of the telecom market, namely in the following domains:

- Consumer world is dominated by intangibles, not driven by technology;
- Mobile telecom is gradually forcing a consumer engagement based on “act now” type of consumer response. This “act now” requires immediate attention and decision making. At the same time, it must involve simultaneous personalization and mass market stimulation;
- Insurance/pain avoidance could be a key market, per individual.

McClelland considers that new business models will not emerge from new economies, but from viewing established behaviours in a new way. He also believes that business models of

the future will depend on deep and universal values and needs like: pain, convenience, money, trust, guilt and privacy (McClelland, 2006).

We briefly present the major new emerging value chains and roles in the telecom industry:

- The 3GPP IP Multimedia System;
- Mobile Broadcast Convergence;
- Ambient Networks.

3.5.1 The 3GPP IP Multimedia Subsystem (IMS)

IMS is defined by 3GPP as a new subsystem, i.e., a new mobile network infrastructure that enables the convergence of data, speech and mobile network technology over an IP-based infrastructure, and it is defined as follows:

“IMS is a specification of a standard service control architecture, which uses common Internet-based protocols to enable integrated, session-based delivery of multiple types of voice and multimedia data services, potentially hosted by multiple different service providers, and potentially over multiple types of fixed and mobile access network” (3GPP.org, 2006).

For users, IMS-based services enable person-to-person and person-to-content communication in a variety of modes – including voice, text, pictures and video, or any combination of these – in a highly personalized and controlled way.

For operators, IMS takes the concept of layered architecture one step further by defining a horizontal architecture, where service enablers and common functions can be reused for multiple applications. The horizontal architecture in IMS also specifies interoperability and roaming, and provides bearer control, charging and security. What is more, it is well integrated with existing voice and data networks, while adopting many of the key benefits of the IT domain. This makes IMS a key enabler for fixed-mobile convergence.

IMS enables services to be delivered in a standardized, well-structured way that truly makes the most of layered architecture. At the same time, it provides a future-proof architecture that simplifies and speeds up the service creation and provisioning process, while enabling legacy interworking. With the use of IMS, the services are not specific to access type or terminal. For example, the videoconference has participants using both fixed and mobile devices. IMS enables this convergence by supporting services independent of access.

With pictures, images, video-telephony and combinational multimedia services, users will be able to vary their communication modes by using any combination of communications media.

In the pre-IMS world, services are specified and supported by a single logical node, or set of nodes, performing specialized features for the service. Each service appears as an island, with its own service-specific node(s). The only possible way to interface between services – for

example, for service composition – is through protocols. In the absence of any common service framework, each service may have to be designed and implemented from scratch.

With the introduction of the IMS architecture, many functions can be reused for fast service creation and delivery. IMS services are hosted by application servers, which means, they are implicitly placed in the IMS application layer, and that various aspects of service control are defined. For example, IMS defines how service requests are routed, which protocols are supported, how charging is performed and how service composition is enabled (Ericsson, 2004).

A single application server may host multiple services, for example, telephony and messaging. Collocation of multiple services has significant advantages, especially with regard to the loading of IMS core network nodes. Collocating services in one application server reduces the workload of a call session control function (CSCF) in the control layer.

IMS provides for a number of common functions that are generic in their structure and implementation, and can be reused by virtually all services in the network. Examples of these common functions are group/list management, presence, provisioning, operation and management, directory, charging and deployment.

In addition to speeding up and simplifying the service creation and delivery process, the reuse of common infrastructure, enablers and competence provided by IMS minimizes OPEX and CAPEX for operators, especially in areas such as service provisioning, O&M, customer care and billing (Ericsson, 2004). Another advantage is that the operation competence required across services is more generic and can be overlaid with service-specific knowledge, rather than demanding specialist operational competence for each service.

3.5.2 Mobile Broadcast Convergence

A proposal has been made by the DVB-UMTS group to identify a new entity called “Cooperation platform”, or mediation platform, and its interfaces to both broadcast and mobile cellular networks.

The telecommunications business area has the characteristics described in table 2.

Table 2: Strengths and weaknesses of telecommunications sector

Strengths	Weaknesses
Large subscriber base (almost everyone has a mobile phone)	Seek to increase ARPU
Secure personal interactivity	Seek to reduce churn
	Low experience in quality content
	Want to limit infrastructures investments (UMTS)

Source: OTE, 2005

On the other side, the broadcasting business area has the characteristics described in table 3.

Table 3: Strengths and weaknesses of broadcasting sector

Strengths	Weaknesses
Attractive content (almost everyone watch TV)	Seek to amortise expensive content on a large scale
Efficient broadcast channel	Seek to enrich services with interactivity and personalization/localization

Source: OTE, 2005

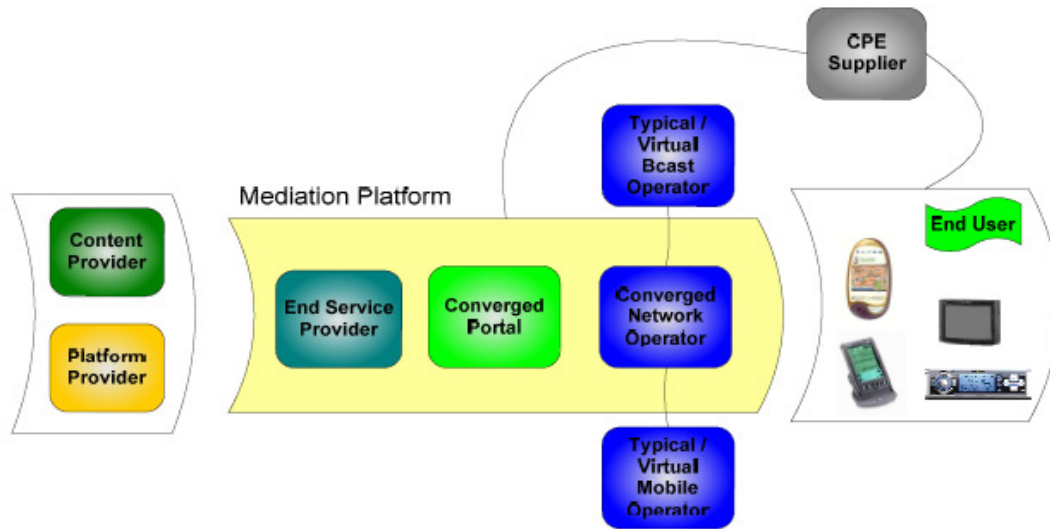
The intention of mobile broadcast convergence is to combine the strengths of digital terrestrial TV and mobile communication. It intends to create a platform that contains mobility, secure personal interaction, authentication/billing, personalization, high transmission capacity and attractive content (Vodafone, 2004).

The operator of such platform addresses different networks to provide a co-operation support. It may be the owner of both broadcast and cellular networks, or may be a third party controlling the traffic conveyed on both the networks. Its role consists mainly to initiate hybrid networks resources control according to:

- Service demands (type of applications, content popularity);
- User features (location, terminal capability) and user requirements (QoS, delivery mode);
- Traffic and network resource optimisation (bandwidth availability, bandwidth cost).

A typical scenario could be the following: content providers send their content catalogue to the mediation entity, which proposes the services to the end-users and manages service innovations (including network selection) thanks to user invocations or profiles, user location and terminal capabilities. This scenario gives a key role to the mediation entity, in particular as unique access point for the end user and suits well with network co-operation requirements (Daidalos consortium, 2006).

On the basics of the mediation platform, a number of scenarios may be identified for the collaboration between a mobile telecommunications network operator and a broadcast operator for a “converged services provider” or “mediation platform operator” to be able to offer services on a co-operative networks solution. The figure 28 depicts a refinement of the possible roles of a mediation platform operator.

Figure 28: Mobile broadcast mediation platform roles

Source: Daidalos Consortium, 2006

The platform providers develop or supply enabling platforms and applications, middleware solutions, managed services, hosting or transaction functions. This category is represented by the network infrastructure vendors, wireless application service providers (WASPs), middleware vendors and applications developers. This kind of actor will be important because a converged service platform should need more complex features due to network cooperation (Daidalos consortium, 2006).

Content providers

The content provider supplies to end-users. Two types of actor are grouped in the category:

- Those who produce and/or own contents such as TV/radio stations, or more generally, the broadcasters;
- Those who aggregate contents by collecting and packaging raw contents from various sources to feed other partners in the value chain, such as portal providers. Most of the times, they provide a range of elementary services from simple reformatting functions to more sophisticated value-added services, such as content personalization.

As most of contents are not specific to the converged platform customers, so they may be sold to other service provider than a converged service provider.

End service provider

The end service provider offers services that benefit from the converged network capabilities to end-users. The service provider may be unique, following a walled garden approach. In that case, the service provider selects the contents and proposes a unique offer to the end-user. In the second approach, the non-walled approach, there are many service providers that can be federated within a converged portal, for example.

Converged portal provider

The mediation portal provider aggregates specific converged services that benefit from network cooperation. This actor may be specialised to a specific customer target (communities of interest, professionals, etc) or offers generalist services.

Converged network operator

In the converged value chain, the network operator uses two different networks and provides the necessary system to make both networks cooperate. The converged network operator can be:

- An actor that has deployed both networks DVB-T and UMTS;
- An actor that controls the traffic conveyed on the broadcast network and the mobile network. In this case, the traditional broadcast and mobile operators are partners of the converged network operator.

Network operators

Broadcasting network operator may be:

- A typical broadcasting network operator that deploys the broadcasting network and implements basic services: data conveying, control access management, possible local contents;
- A virtual broadcasting network operator who rents a resource from a broadcasting network operator.

Mobile network operator can be:

- A typical mobile network operator. It provides network connectivity, location and presence information, an access to billing system, customer databases and manages quality of services;
- An MVNO has the same activities of a typical mobile network operator but relies on a typical mobile network operator for radio frequency allocation and infrastructure.

Device Suppliers

The role of the device manufacturers is to provide the appropriate terminals. Two cases are foreseen:

- The terminal may be specific, which means to establish collaboration between the device manufacturer, the service provider and the network provider;
- Or, the terminal may be a combination of two terminals: a GPRS/UMTS classical terminal and a mobile DVB-T device (for instance, a pocket PC with a mobile DVB-T/DVB-H modem) connected by a wireless link such as a Bluetooth liaison.

In both cases, this actor will assure the interoperability between the end-user terminals and the service provider.

3.5.3 Ambient Networks

The rising importance of ambient networks in future communications landscape has made industry looking at such solutions with great interest. However the evolution and commercial implementation of ambient networks is hindered by the lack of proven solutions for security and charging in such volatile networks.

Ambient networks extend all-IP networks by several innovations. The extensions build on the demand for enabling communication between different social and economical realms as identified by the Internet research community. The three main innovations are network composition (beyond simple Internetworking), enhanced mobility and effective support for heterogeneity in networks.

Network Composition

One basic mechanism of the ambient networks approach is the dynamic, instant composition of networks. Composability as required for ambient networking goes beyond what the Internet and mobile networks provide today. Internetworking shall happen not only at the level of basic addressing and routing, but additional functions for incorporating higher layer support (such as content distribution or service control functions) are required. Ambient networks will deploy an universal framework for network composition, as an approach for building a unified communication support out of the resources of individual networks, which can be specialised for particular types of access technologies or business models.

Network composition in ambient networks has to function across operator and technology boundaries, provide a security framework and has to be executable without user involvement. In addition, the execution of the composition process has to be rapid in order to follow fast topology changes as expected, for example, for mobile Personal Area Networks (Niebert, 2006).

Mobility

Existing IP-based mobility solutions target either intra-domains mobility within a static network architecture or roaming solutions across domain boundaries. Ambient networks focus on integrated mobility concepts not only applicable for both of the above scenarios, but also integrating localized communications, e.g., in PANs, and device-device interactions. In dynamically composed network architectures, mobility of user group clusters can support effective local communication. Furthermore, mobility must interact efficiently with the control interfaces needed to enable quality of service and optimal routing and re-routing of individual multimedia flows. An ambient network mobility solution will have to work well across business and administrative boundaries, which requires solutions for the security issues and inter-domain operation (Niebert, 2006).

Heterogeneity

Ambient networks will be based on a federation of multiple networks of different operators and technologies. On the one hand, this leads to increased affordability of ubiquitous communication, as the user has full freedom to select technology and service offering and the investment needs for new networks are reduced. On the other hand, networks will have to

integrate the capabilities of different technologies to an end-to-end, seamless and secure solution for the user.

Ambient networks take a new approach to embrace heterogeneity visible on different levels, such as link technologies, IP versions, media formats and user contexts. Diversity of access links, especially of links provided by mobile networks, is supported by a generic link layer concept, which will efficiently enable the use of multiple existing and new air interfaces.

The vision of ambient networks is that users and operators can jointly exploit available radio and network resources for a broad range of services. To enable this vision, the concept builds on a common set of control functions, dynamically (re-)configurable and universally available.

To evolve today's mobile networking into this vision, the current systems need to be analyzed, especially from a user's perspective as outlined above. Currently, the lack of commonly available and configurable control functions and dependence on network technologies and ownership is a major obstacle to further rapid growth. Ambient networks takes up the challenge of defining an essential set of universally available and usable control functions. To achieve this, it defines a conceptual framework including the control functions necessary to achieve the required network capabilities. This framework is based on the following three principles:

- Ambient networks build upon open connectivity and open networking functions;
- Ambient networks are based on self-composition and self-management;
- Ambient networks functions can be added to existing networks.

This approach yields the following advantages:

1. Network operators can decide what level of support they want to give to users and business partners, based on flexible sets of network control and composition functions. Affordable and simple as well as service rich networks can be built without restricting the integration into the global connectivity. Existing networks can be integrated and furthermore new technologies can be introduced in a coherent way;
2. End-users select between different control functions on their devices or personal networks, which provides the feature rich service environment they like to use. Innovation is nurtured by the opportunity to develop any service on top of the basic connectivity with as few barriers as possible because of the simple but extendable connectivity interfaces;
3. Service providers can easily address large numbers of users and deliver their specific services to them without having to worry about their user's access or network capabilities.

4 Innovation Process in Telecommunications Field

4.1 Short Overview

In this chapter we look to the innovation process in the telecommunications industry. In a first instance (section 4.2) we characterize the innovation process looking essentially to the diverse types of innovations, purposes of innovation policies and present the major causes of innovations' failure. Subsequently (section 4.3) we briefly present the most important disruption events in the voice telephony market and data market and we realize the importance of the technical standardization in the development of innovations within the telecommunications sector. Later (section 4.4) we describe the concept of open innovation promoted by Henry Chesbrough and the changing perspective from traditional innovation to open innovation. At last (section 4.5) we analyze the impact of Open Source in the telecommunications market. In this last section we describe the major characteristics of Open Source software, we present the most important Open Source business models, we look to the status of Open Source software in the telecommunications industry and finally we divulge some initiatives that intend to promote the development of open software inside the telecommunications industry.

4.2 The Innovation Process

The notion of innovation is not consensual as it can be related with the concept of creativity as well as to organizational or management changes. Some usual definitions of innovation include:

1. the process of making improvements by introducing something new;
2. the introduction of something new (Merriam-Webster Online, 2007);
3. a new idea, method or device (Merriam-Webster Online, 2007);
4. change that creates a new dimension of performance (The American Heritage Dictionary, 2002).

One more complete notion of innovation was defined by the UK Government Innovation Report that defines innovation as “the successful exploitation of new ideas” (Christensen, 2001). It continues: “ideas may be entirely new to the market or involve the application of existing ideas that are new to the innovating organization or often a combination of both. Innovation involves the creation of new designs, concepts and ways of doing things, their commercial exploitations, and subsequent diffusion throughout the rest of the economy and society”.

The term innovation may refer to both radical and incremental changes to products, processes or services. The often unspoken goal of innovation is to solve a problem. Innovation is an important topic in the study of economics, business, technology, society and engineering. Since innovation is also considered a major drive of the economy, the factors that lead to innovation are also considered to be critical to policy makers.

Looking inside the economic conceptions of innovation, Joseph Schumpeter defined economic innovation in 1934 as:

1. The introduction of a new good, that is one with which consumers are not yet familiar;
2. The introduction of a new method of production, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially;
3. The opening of a new market, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before;
4. The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created;
5. The carrying out of the new organization of any industry, like the creation of a monopoly position (for example, through trustification) or the breaking up of a monopoly position.

This vision of innovation is also studied by economists in a variety of contexts, for example, in theories of entrepreneurship.

There are different types of innovation, including for example:

- Business model innovation – involves changing the way business is done in terms of capturing value;
- Marketing innovation – is the development of new marketing methods with improvement in product design or packaging, product promotion or pricing;
- Organizational innovation – involves the creation or alteration of business structures, practices, and models, and may therefore include process, marketing and business model innovation;
- Process innovation – involves the implementation of a new or significantly improved production or delivery method;
- Product innovation – involves the introduction of a new good or service that is new or substantially improved. This might include improvements in functional characteristics, technical abilities, ease of use, or any other dimension;
- Service innovation – is similar to product innovation, except that the innovation relates to services rather than to products;
- Supply chain innovation – where innovation occurs in the sourcing of input products from suppliers and the delivery of output products to customers.

In addition to dividing innovations into types, innovation is often characterized by its impact on existing markets or businesses. Sustaining innovations allow organizations to continue to approach markets the same way. Disruptive technology on the other hand, significantly changes a market or product category.

For the leading firms, the new technologies offered their existing customers little advantage. The success of the disruptive technology often promised lower profit margins to established firms. The decision makers values and the goals of the firm forbid giving serious consideration to technologies that will destroy an established market. These disruptive technologies were adopted by small firms that were not established in the market, and for whom adoption of the disruptive innovation represented a new opportunity.

Similarly, incremental innovation is evolutionary innovation, a step forward along a technology trajectory or from the known to the unknown, with a high chance of success and low uncertainty about outcomes. Radical innovation, on the other hand, involves larger leaps of understanding, perhaps demanding a new way of seeing the whole problem, probably taking a much larger risk than many people involved accepts. The chances of success are difficult to estimate. There may be considerable opposition to the proposal and questions about the ethic, practicality or cost of the proposal may be raised. People may question if this is, or is not, an advancement of a technology or process.

Programs of organizational innovation are typically tightly linked to organizational goals and objectives, to the business plan, and to market competitive positioning. For example, one driver for innovation programs in corporations is to achieve growth objectives. Davila says:

“Companies cannot grow through cost reduction and reengineering alone...Innovation is the key element in providing aggressive top-line growth, and for increasing bottom-line results” (Davila, 2006).

In general, business organizations spend a significant amount of their turnover on innovation, i.e., making changes to their established products, processes or services. The amount of investment can vary from as low as a half a percent of turnover for organizations with a low rate of change to anything over twenty percent of turnover for organizations with a high rate of change.

One survey across a large number of manufacturing and services organizations found, ranked in decreasing order of popularity, which systematic programs of organizational innovation are most frequently driven by (CIO, 2005):

1. Improved quality;
2. Creation of new markets;
3. Extension of the product range;
4. Reduced labour costs;
5. Improved production processes;
6. Reduced materials;
7. Reduced environmental damage;
8. Replacement of product / services;
9. Reduced energy consumption;
10. Conformance to regulations.

These goals vary between improvements to products, processes and services and dispel a popular myth that innovation deals mainly with new product development. Most of the goals could apply to any organizational, be it a manufacturing facility, marketing firm or local government.

Attaining goals must be the ultimate objective of the innovation process. Unfortunately, most innovation fails to meet organizational goals.

Statistics vary considerably depending on the research. One survey regarding product innovation quotes that out of three thousand ideas for new products, only one becomes a success in the marketplace. Failure is an inevitable part of the innovation process, and most successful organizations factor in an appropriate level of risk. The impact of failure goes beyond the simple loss of investment, can also lead to loss of morale among employees and can increase the resistance to change in the future.

Innovations that fail are often potentially 'good' ideas, but have been rejected or 'shelved' due to budgetary constraints, lack of skills or poor fit with current goals. Failures should be identified and screened out as early in the process as possible. Early screening avoids unsuitable ideas devouring scarce resources that are needed to progress more beneficial ones. Organizations can learn how to avoid failure when it is openly discussed and debated. The lesson learned from failure often resides longer in the organizational conscientiousness than lessons learned from success. While learning is important, high failure rates throughout the innovation process are wasteful and a threat to the organization's future.

The causes of failure have been widely researched and can vary considerably. Some causes will be external to the organization and outside its influence of control. Others will be internal and ultimately within the control of the organization. Internal causes of failure can be divided into causes associated with the cultural infrastructure and causes associated with the innovation process itself. Failure in cultural infrastructure varies between organizations, but the following are common across all organizations at some stage in their life cycle (O'Sullivan, 2002):

1. Poor leadership;
2. Poor organization;
3. Poor communication;
4. Poor empowerment;
5. Poor knowledge management.

Common causes of failure within the innovation process in most organizations can be distilled into five types:

1. Poor goal definition;
2. Poor alignment of actions to goals;
3. Poor participation in teams;
4. Poor monitoring of results;

5. Poor communication and access to information.

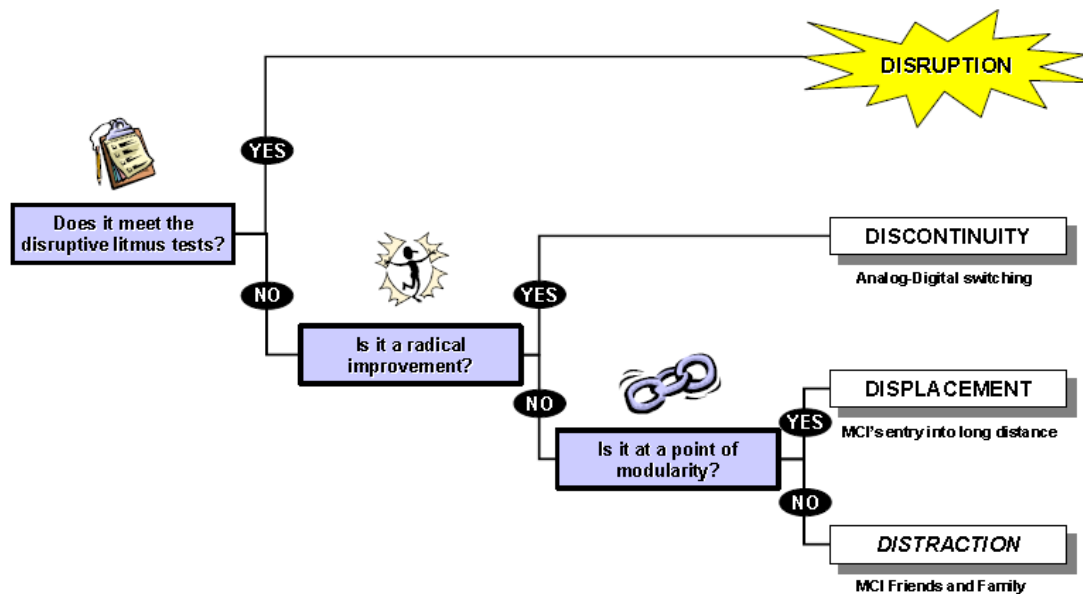
Goal definition requires that organizations state explicitly what their goals are in terms understandable to everyone involved in the innovation process. This often involves stating goals in a number of ways. Alignment of actions to goals means linking explicit actions such as ideas and projects to specific goals. It also implies effective management of action portfolios. Participation in teams refers to the behaviour of individuals and teams. It also refers to the explicit allocation of responsibility to individuals regarding their role in goals and actions and the payment and rewards systems that link individuals to goal attainment. Monitoring of results refers to monitoring all goals, actions and teams involved in the innovation process. Finally, communication and access to information refers that not all the organization has the same tools to contribute for the improvement of the company. Sometimes, top leaders of the company have access to previously information, and they don't look interesting to share this information among the company's staff.

4.3 Impact of Radical Innovations

The rapid pace of technological development in telecommunications is based on a stream of innovations, many of which are radical. However, explaining this in terms of current innovation theory is difficult. In current theories, radical innovations are variously attributed to haphazard scientific breakthroughs, chance, serendipity, etc (Godoe, 2000). Contrary to this, empirical evidence in telecommunications suggests a systematic relationship between science and technology-based R&D and the emergence of radical innovations (Godoe, 2000).

Numerous radical technological innovations introduced during the past decade have created new telecommunications systems, services and/or radically modernized old ones, such as the telephone network. Following current technological innovation theories, radical innovations may inaugurate the emergence of new technological paradigms, initiating developmental patterns variously termed as "technological trajectories" (Dosi, 1988). However, disruption is not the only form of important change that affects an industry. Clayton Christensen developed an additional taxonomy of industry change called the "4-D" model.

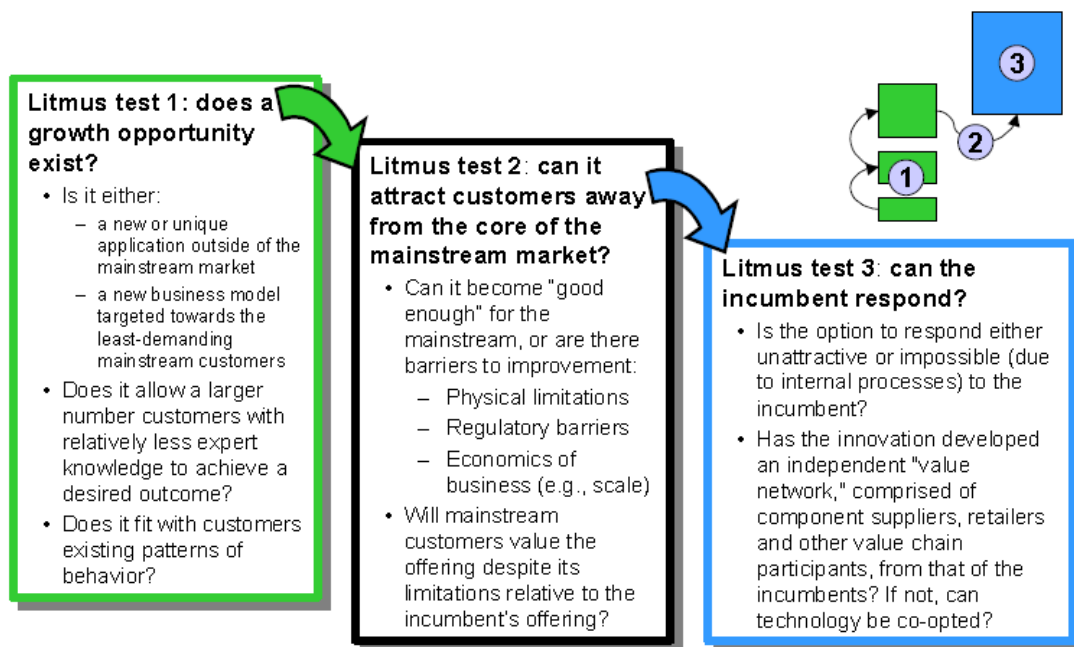
Figure 29: The 4D industry change classification model



Source: Christensen, 2001

The classification about the type of change a firm experiences isn't easy. The first question that managers must ask is whether the change meets the criteria defined as disruptive "litmus test". There are three key litmus tests to determine whether a technology will be disruptive or not (Figure 30).

Figure 30: Detailed disruptive litmus tests



Source: Christensen, 2001

The first test determines whether there is a large new growth opportunity that gives the technology a "home" to incubate and improve. The next key test a disruptive technology will

face is getting “good enough” to attract customers away from the sweet spot of the mainstream market. The final, and most important, litmus test an innovation must pass is whether the incumbent, who “owns” the core mainstream market, can fend off the attack from below or whether it must “retreat” up-market. This process is iterative like it is described in figure 30.

If the change does not meet the litmus tests, it is one of three separate types of sustaining innovation. It is important to distinguish between sustaining and disruptive innovations, because sustaining innovations can be mastered and controlled by incumbent firms, while incumbents are powerless to defend against disruptions. Also start-ups with sustaining technologies should adopt a very different “go-to-market” approach than those with potentially disruptive innovations (Christensen, 2001).

If a change is not disruptive, the next question asked on Figure 30 is whether it is radical or incremental, with a radical change termed a discontinuity. Discontinuities, which also can be termed radical sustaining innovations, are more expensive, more complicated but better performing technologies that either meet or exceed the current needs of the mainstream market.

If a change is incremental, the next key question is whether it occurs at a point of “modularity” or a point of “interdependence”. An architecture is interdependent at an interface if one part cannot be created independently of the other part. In contrast, a modular interface is a clean one, in which there are no unpredictable interdependencies across components or stages of the value chain (emergic.org, 2007).

Each type of innovation classified in the 4-D classification scheme contains the characteristics described in the table 4.

Table 4: Predictive factors for 4-D classification scheme

Disruption	Distraction
Most likely at a point of modularity: system & product interdependence are well understood and measurable	Typically led by an incumbent
Often conceptualized in an incumbent, but commercialized within a new entrant (resource allocation prevents disruption from within)	At a point of interdependence
Initially targeted at niche market segments; perceived to be inferior or not good enough for mainstream customers	Targeted at mainstream customers
Initially worse along primary basics of competition in mainstream market, but better along other dimension	Equivalent or marginally better on primary basics of competition in mainstream market; fits incumbent values
Discontinuity	Displacement
Led by an incumbent	Often initially led by new entrants offering new product or service
Requires system-wide changes	At an existing or emerging point of modularity
At a point of interdependence	Targeted at mainstream customers
Targeted at mainstream customers	Equivalent or marginally better on primary basics of competition in mainstream market
Substantial improvement along primary basis of competition in mainstream market	Can fit into “values” of incumbents

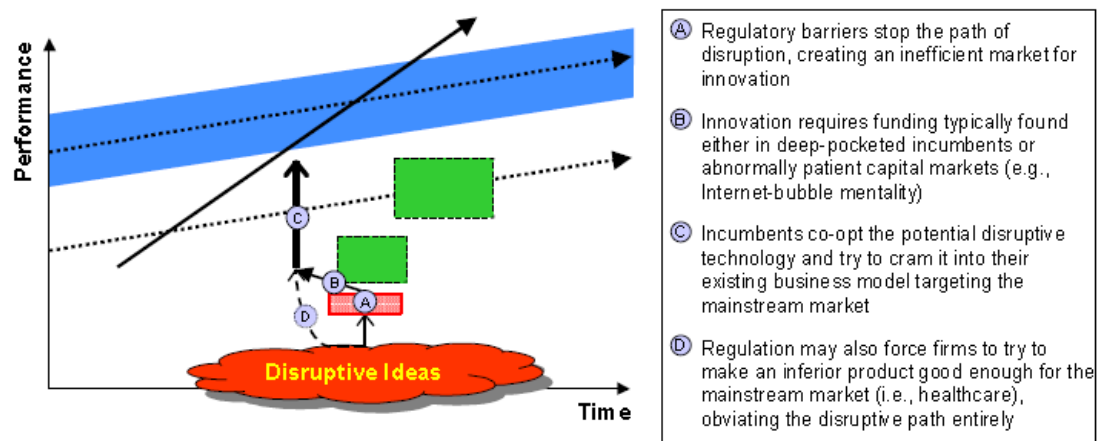
Source: Christensen, 2001

4.3.1 Drivers of Change in the Voice Telephony Market

The telecommunications industry has gone through a tremendous amount of change, especially over the past 20 years. The introduction of a competitive market for long distance services and the upgrade of the PSTN backbone from analog to digital to fiber are examples of events that have forced major changes on incumbent service providers. While each of these changes was substantial and important, none led to the radical reshaping of an industry that comes from disruption.

Given its omnipresence in the industry, it is not surprising that regulation plays a major role in distorting the disruptive process. From the Consent Decree in 1956 to the Modified Final Judgment in 1984 to the Telecommunications Act of 1996, regulation has played a pivotal role in industry development. In the figure 31, we show a brief overview of the effect of regulation.

Figure 31: Overview of the effect of regulation



Source: Christensen, 2001

Christensen considers that there are two specific areas where regulation influences the forces of innovation:

Stops disruptive innovations by exacerbating incumbent cramming

For a disruptive technology to be successful, it must be introduced to the “right” group of customers. However, regulation makes the “market for innovation” inefficient by creating artificial barriers (shown as a brick wall on figure 31) that prevent innovations from finding these customers. For example, the government’s tightly controlled allocation process over a limited amount of wireless spectrum makes it difficult for a new entrant to target a niche segment.

Regulation can also exacerbate incumbent cramming by forcing a potential disruptive technology to stretch to meet the needs of the most-demanding customers. For example, regulation in health care only allows the introduction of products that are able to serve all

type of patients. This policy deflects the potential disruptive path of a new technology, as, by definition, a disruptive technology is not initially good for the most-demanding customers.

Forces artificial interdependence/encourages inappropriate modularity into a marketplace

Regulation affects industry change by “artificially” influencing the makeup of the industry, either forcing artificial interdependence or encouraging inappropriate modularity. In this situation, the local loops are essentially a natural monopoly with an incumbent regulated monopoly controlling a highly interdependent system. Any effort to force modularity on the system was doomed to fail, as a market of specialists would not be capable of managing the complex interdependencies in the system. Unbundling elements of the local loop did not create accessible interfaces; it transformed central offices into competitive “war-zones” full of questionable tactics and finger pointing. Even if the incumbents had allowed new entrants completely unfettered access, the interdependence if the system would have made it very difficult for specialists to be successful.

In the 1990s, a number of individuals in research environments, both in educational and corporate institutions, took a serious interest in carrying voice and video over IP networks, especially corporate intranets and the Internet. This technology is commonly referred today as VoIP and is, in simple terms, the process of breaking up audio or video into small chunks, transmitting those chunks over an IP network, and reassembling them at the far end so that two people can communicate using audio and video (Tarkovsky, 2007). While sending voice in packets is not a new concept (Asynchronous Transfer Mode (ATM) has existed for many years), technology has only recently gotten good enough to allow for voice to serve as a data application. As the VoIP story is complex, there are several important factors to keep in mind during the following analysis:

- It is vital to consider the distinction between transport and services. Transport (sometimes called “naked connectivity” or simple 1-plus dialling) is provided over the physical connection media between communication nodes. Services refer to value-added features that telecommunications companies sell to customers and business that enhance the functionality of the communications network. Services range from basic services handled at the local level (e.g., voice mail and 3-way calling) to relatively advanced services that handled at the network level (e.g., call-center management, 800 services);
- Providing advanced, network-based voice services such as 800 services or call center management requires more than a single solution;
- The disruptive potential of VoIP-based advanced services will depend on the development of independent value networks capable of incubating the technologies completely outside of the traditional service provider networks.

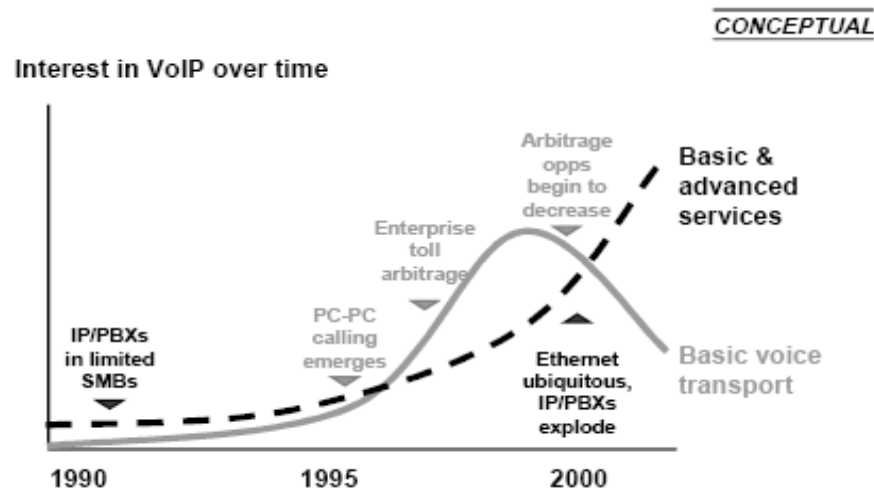
It's also important to examine the VoIP's initial commercialization as a tool to provide pure voice connectivity and the VoIP's deployment as a means to provide basic and advanced voice services within enterprises through IP/PBXs and related solutions.

The initial commercialization of VoIP

As the Internet began its explosive growth in the mid-1990s, hackers were entranced by the concept of using their PCs to get around oligopolistic access charges on long distance and international phone calls. Although the high latency and jitter led to inferior call quality intolerable to most users, students and immigrants were delighted by the almost-free calls. Companies like *Net2Phone* and *DialPad* sprung up to latch on the new growth opportunity, eventually adding pre-paid calling cards to let people make VoIP calls from regulator telephones. The arbitrage opportunity spread to the enterprise, with companies using gateways to allow VoIP to provide basic voice connectivity. While companies continue to take advantage of "green space" developments in the "naked voice connectivity" market, this story is more about arbitrage-enabled displacement than disruption (Christensen, 2001). As long distance rates continues to decline, this arbitrage opportunity is largely dissipating except for international calls.

VoIP in the enterprise: IP/PBXs

While consumers were enjoying the novelty of almost-free international calls on their PCs, the "wave" of disruption in the enterprise resulted in the foundation for the true emergence of VoIP. The wave of disruption and the subsequent build out of IP-related technologies resulted in very low prices for Ethernet, leading to the deployment of switched 10/100 megabit per second Ethernet to every desk within most corporations. The open standards embodied by IP allow services to be decoupled from the transport media. While IP/PBXs, which essentially allow companies to have all traffic within the "walled garden" of their enterprise data network be IP-based, have been around for more than 10 years (with limited deployment in small and medium businesses, depicted on figure 32 as the slowly rising dark line), these technological developments allowed them to move from concept to real deployment within a corporation.

Figure 32: Link between residential and enterprise VoIP

Source: Christensen, 2001

The deployment of VoIP within corporations in the edge of the network with IP/PBX solutions can be considered definitely disruptive (Christensen, 2001). While still plagued by relatively poor functionality, IP/PBXs present some distinct advantages, providing the potential for significantly more convenience and flexibility than traditional telephone services. Specifically, it:

- Facilitates “unified messaging” with voice-mail, e-mail and faxes all in a single location;
- Makes the “move/add/drop” process extremely easy. Users can “plug in” anywhere within the corporation and have their regular telephone number;
- Allows new and novel convergence-enabled features, combining voice, video and data;
- Lets corporations use a single architecture for all of their traffic needs instead of maintaining separate networks.

IP/PBXs and related services are creating new “green space” opportunities, with some companies targeting departments or offices within large corporations and other targeting small and medium businesses. Companies like *Cisco* are targeting large enterprises, while start-up companies like *Mitel* are focusing their efforts at small or medium businesses (Lee, 2001). It appears that both are logical “green space” opportunities:

- Cisco’s approach to target large enterprises, a subset of the mainstream market, follows the lessons learned from the deployment of other disruptive technologies in the enterprise. Large enterprises have the most to gain (e.g., cost savings) from moving towards a converged data/voice network, and also have the scaled data networks that have enough reliability to conceivably support voice as a data application. Additionally, large organizations have the budgets to support new technological deployments;
- Start-ups who are offering Application Service Provider (ASP) offerings to small and medium businesses (SMB) are following a different but still valid “green space” approach. Small and medium businesses are clearly overserved by traditional PBX

manufacturers, and, in fact, many SMBs cannot afford most PBX offerings. They also might be much more willing to “tolerate” problems with IP/PBXs – for SMBs two or one-nine reliability might be acceptable.

4.3.2 Disruption in Data

The business market has always been a catalyst for change and innovation in telecommunications and today we see the same pattern emerging in the enterprise data market. Data has always been as important to businesses as voice has been to consumers. As voice becomes a data application industry dynamics will change and data will become an increasingly important driver of industry change. In particular, the spread of IP Internetworking has sparked a wave of market disruption that appears poised to topple the circuit-switched networking paradigm that has dominated the last century.

The data enterprise market, with its low regulatory hurdles and high density and value per user, has proved fertile ground for the incubation of disruptive business models. Technologies have been able to improve mostly unencumbered by the regulatory and technological barriers that exist in the residential market. To date, traditional service providers have remained largely insulated from these disruptions, instead benefiting as the rise in networking has led to increased demand for bandwidth and connectivity. The emergence and rapid improvement of VoIP technologies provide companies with a reliable way to translate voice traffic into data packets and route them over existing IP private data networks, enabling new functionality and eliminating the need to pay access tolls. For incumbent service providers, IP-based networking creates both threats and opportunities that cannot be ignored.

The first disruption: Interoffice communication

In the early 1980s, the *Institute of Electronics and Electrical Engineers* (IEEE) defined standards for networking computers in the local area. While few realized it at the time, Local Area Network (LAN) standards would become the building block of one of the most powerful disruptive forces in process today within telecommunications: the emergence of the “any-to-any” networking paradigms.

The rise of the minicomputer and the PC in the early 1980s created demand for scalable, flexible and efficient high bandwidth corporate data networks as computing power became more distributed. Prior to the PC’s introduction, enterprise computing was dominated by centralized mainframes with costly and difficult to implement customized applications and functionality was limited to what could be developed by corps of professional programmers. While most major corporations did employ a tremendous amount of information technology, these large, expensive mainframes typically were reserved for the most demanding and complex jobs: mission-critical business applications (e.g., accounting functions, transaction processing, payroll, etc.).

LAN was the first major identifiable disruptive technology in the data enterprise market. Taking root in a true “green space” market, LAN technology got good enough to completely disrupt the labour intensive “sneakernet” that exemplified office communications. Prior to

the introduction of LANs, inter-office communications had experienced relatively little change since the introduction of the telephone. While the fax machine had introduced the ability to send data over existing telephone lines, inter-office communication remained relatively unsophisticated, relying on slow, manual processes. Typing pools (legions of typists responsible for the creation of office documents), memo distribution boxes and the classic mail system were essential components of the modern day enterprise. They were highly accurate and had the “personal touch” that provided a high sense of reliability to their consumers.

PCs introduced users to the countless ways to simplify work tasks and improve efficiency within a typical corporate functional department. Users quickly discovered communication and information sharing could be dramatically improved by connecting PCs together, with LAN technology as the key connector, to create rudimentary networks.

LAN technology quickly pulled customers out of the mainstream inter-office communications market. Word processing and email quickly obviated the need for memo typing pools and their manual distribution processes. Additionally, once connected, users could transfer files, share expensive laser printers, and almost effortlessly circulate pertinent information.

IP Networking Takes Over the Corporate Data Transport Market

While the LAN was terrific to connect small offices or adjacent buildings in a local area, networking users in geographically disparate locations required more robust networking solutions. LAN technology was not good enough to support the huge number of users and devices found on a typical enterprise data network. The introduction of the multi-protocol router was the pivotal development that turned the data-networking world upside-down and enabled the disruption of both incumbent networking companies, created by the disruption of sneaker net and data transport businesses.

A LAN network presents a lot of advantages, namely in the following domains:

- Decentralized Scalability – built with cheap, simple to connect equipment based on open standards (Ethernet) that could be purchased “off the shelf”;
- Cost savings – reduced expenses by permitting the sharing of expensive peripherals (e.g., printers, fax modems, Internet modems, etc.) as if they were directly attached. It also enabled high speed data transfer without the cost of purchasing bandwidth;
- Time savings – eliminated the need for floppy disks as file sharing moved to the network. It also enabled email and other collaborative tools (Calendaring/Scheduling).

On the other side, LAN presents some challenges that are incomparability less important than its advantages, especially in these domains:

- Limited distance – LAN were only effective over short distances;
- Network degradation – LAN performance decreased with an increased number of users;

- Error correction and quality of service (QoS) – LAN lacked the high reliability of dedicated circuit connections between network nodes;
- Bandwidth requirements – increased network usage created the need for higher capacity connections between nodes that required upgrades to higher capacity, more expensive connections from existing fixed infrastructure.

Developed out of the need to manage exponentially increasing LAN data traffic, the multi-protocol router “spoke” the varied “dialects” (Appletalk, Ethernet, Xerox, Novell, etc.) of the LAN, translated them into IP and layered on intelligence that forwarded packets towards their ultimate destination. Easily added to any network, these routers enabled LANs to be interconnected within the “green space” of departmental networks in a manner that minimized network degradation and increased network efficiency while allowing any device on the network to communicate with any other device. Early networking companies such as *Novell* and *3Com* that used proprietary networking standards found themselves unable to compete with the open, any-to-any computing architecture created by the multi-protocol router created. The router’s IP-based technology was cheaper, more flexible and scalable.

As email and file sharing became essential components of business, demand for enterprise communication networks increased resulting in a huge build out of IP networks. This build out funded the router’s rapid improvement in reliability and security, two attributes that were very important to the managers of mission-critical data networks.

The central question is whether wireless service, with its many data-oriented enhancements in upcoming 2.5G and 3G standards will get “good enough” for the high-speed data needs of the average consumer. Based on the untold billions spent in spectrum auctions across the globe, it would seem that many operators assume the answer is yes. However, 3G operators appear to have fallen prey to a pernicious “double cram” that further deflects the disruptive trajectory of wireless (Christensen, 2001). The first cram occurred when 3G was conceived more than 10 years ago. Industry players viewed 3G as a way to tap into the burgeoning high-speed data communications market. Hence, they worked to develop a standard that would allow the seamless provision of up to two megabits per second of data. Planners hoped to stretch the technology to meet the needs of the most-demanding user of the time, instead of targeting a market that would be delighted by data mobility even at relatively slow rates.

While 3G was primarily designed to enhance voice service by better managing capacity, the rise of the Internet and the belief that next generation data applications would drive significant profit opportunities has placed a greater emphasis on 3G’s data transmission capabilities. As average revenue per user has stabilized, wireless operators are searching for new ways to drive revenue growth, primarily through data services. With the initial 3G standard never implemented, potential operators are “cramming” all over again by trying to market 3G on its high-speed data attributes to the most-demanding customers.

Wireless LAN versus 3G

While wireless operators continue to trudge towards rolling out 3G services across the world, Wireless LAN (WLAN) pundits argue that services running on the 802.11x standard (also known as WiFi) and rely on unlicensed spectrum in the 2.4 or 5 gigahertz band threaten to

disrupt 3G before it ever comes to fruition. WLANs already appear to have passed litmus test one and are in the process of creating attractive new growth opportunities. This relatively cheap and simple to deploy high speed wireless data technology uses unlicensed spectrum to achieve reliable data transfer rates (up to 11mps) that in many cases exceed the capabilities of 3G. However, as with most disruptive technologies, early interactions of WiFi leave great room for improvement, with issues related to limited distance, presence management and security all representing big concerns. Even with these limitations, WLANs are following the “golden rule” of networking technology adoption, gaining a significant foothold within the enterprise at the departmental level and then expanding to enterprise applications in “hot-spots” such as airport lounges, coffee shops, airports and conference centers.

Despite its exciting growth and growing chorus of industry watchers who excitedly hail its disruptive potential, WLANs look significantly less disruptive through the lens of litmus test two. Without widespread deployment mainstream customers are unlikely to eschew 3G and embrace 802.11x WLANs. Current operators are attempting to band together to create roaming and billing relationships to allow the fragmented market to offer a semblance of national coverage and services. However, government limitations on the use of unlicensed spectrum and constraints based on the physics of the technology (e.g., power, range, interference with other devices such as cordless phones and microwaves) are likely to keep 802.11x WLANs out of the mainstream market of the mobile consumer (Christensen, 2001).

While disruptive technologies and innovative businesspeople often find unanticipated ways around constraints, government-imposed barriers limit potentially novel solutions. If 802.11x can find a way to enter the mainstream market, its prospects to pass litmus test three and unseat incumbents are somewhat more promising. WLAN providers could choose data-based business models that would prove difficult for incumbents to respond to. Also, WLAN providers are growing in a moderately independent value network from incumbent service providers. The largest point of interdependence is at the point of network access. If WLANs access the networks through incumbent service providers, they present an easy avenue for co-option. However, if they choose to access the network through independent Internet Service Providers or MAN providers, they could develop a completely freestanding value network that could facilitate the ultimate disruption of incumbents. The essential question is: can the new wireless competitive access providers (CAPs) create public networks of minimum equivalent functionality and scale to be appealing enough to pull enough customers from the mainstream market?

4.3.3 Innovation Regimes and Standardization

The concept of innovation regime was developed in a study (Godoe, 1995) in order to explain the innovations found in analyzing the R&D based innovations in telecommunications. Based on an ex post R&D portfolio analysis of a Norwegian telecom R&D organization during a 10-year period (1980-1990), the study identified R&D results which subsequently contributed to the creation of innovations in terms of telecom systems, services and/or components, equipment and techniques.

The study confirmed what numerous analysts have observed: in the development of telecommunications, technical standardization has a fundamental, strategic role (Rosenberg, 1994; Hawkins, 1996).

Of the standardization bodies, the most important were the following:

- *NORDTEL*, a formalized institution for cooperation among the Nordic telecommunications network operators. The successful cellular mobile communication system NMT, which was inaugurated in 1981, was a direct result of the work initiated by *NORDTEL*. The subsequent development of the GSM mobile communication system was also supported by *NORDTEL*;
- CEPT, together with *European Broadcast Union* (EBU) and *European Space Agency* (ESA), each had a complex system of technology committees and working groups aimed at technological standards setting and development of pan-European telecommunications systems and services;
- *International Telecommunications Union* (ITU), in particular groups working in ITU's sub-organizations like *International Consultative Committee on Telephony and Telegraphy* (CCITT) and *International Radio Consultative Committee* (CCIR) were important in the creation of many new communication systems and related standards. These organizations provided mechanisms and a framework for R&D collaboration (Godoe, 1998).

Technical standardization plays a crucial role in the development of innovations within the mobile telecommunications sector, as for example NMT and GSM in the Nordic and European context. These standards did however emerge in a certain context, in particular facilitated by international cooperation between the R&D departments of PTT-owned telecommunications operators (Godoe, 1998). Through standardizing organizations, researchers representing national European telecommunications operators and the industry have discussed and harmonized technological platforms that did not previously exist. Largely, these actors were homogenous in preferences, interests, and priorities and thus were well prepared for consensus making. The standardization of Content Provider Access (CPA) on both the business model and platform level unfolds outside the scope of existing telecommunications standardization institutions, but also outside their control. This can be attributed to the many levels of openness that signifies convergence process. For example, the actors now engaging in negotiations and coordination are either unknown to each others, or in fierce competition. The nature of convergence is also magnifying the conflict of interests between the Mobile Telecommunication Operators (MTOs) and the content providers as the borders between their businesses and assets are blurring and possibly shifting.

Telecommunication markets are being increasingly liberalized. Sector specific regulation has been replaced by ex-post anti-trust legislation and the monopoly of the PPT-owned operators is deregulated. One side effect of these processes is that the R&D departments of telecommunications operators have lost their cooperative ties, not only because they are in fierce competition (nationally and internationally), but also because of the fear of anti-trust legislation. The process of convergence is at the same time resulting in the deterioration of the ability and power of telecommunications operators to control standardization and

innovation alone. Even if their control have been challenged through history by national governments in particular related to telecommunications policies.

MTOs give content providers access to transport and billing services (premium charged SMS) through the implementation of CPA platforms. This enables the provision of content services to subscribers with a feasible business model for billing the content. The services provided by CPAs are typically ringtones, logos, jokes and simple information services such as stock quotes, phone directories and weather forecasts. In addition, interactive-TV enabled SMS as a return channel is a growing business, counting for 15 percent of the turnover (Nielsen, 2003).

The standardization of CPA has unfolded outside the scope and the control of the telecommunications standardization regime, and therefore requires new and different institutions for coordination. CPA is not a result of technical standardization prior to the implementation of the CPA-platforms. It is built on the coordination among the MTOs and an evolutionary technical implementation as the market and the nature of the services become apparent and further develops. Within this environment, MTOs have the power to influence the development of the standard, but the power is unevenly distributed among them as well as shared with the content providers. As the standardization process is made open by convergence, these actors together face the paradox of conflicting interests while at the same time having a common and strong need for cooperation and standard making.

The standardization process within Information and Communication Technology (ICT) can be defined as the process by which two or more actors come to agree upon and adhere to a set of technical specifications of an ICT system, its parts or its functionality, either tacitly or as a result of a formal contract (Greenstein apud Fomin, 2003). To achieve such an agreement, actors must do the following:

1. Signal their willingness to develop a standard;
2. Participate in formulating the principal concept and scope of the standard that makes sense for them;
3. Agree on the exact content and form of the standard;
4. Develop a contractual agreement for “gives” and “takes” in relation to standardization process and its outcomes;
5. Agree upon what conforming to the standard specification actually means.

The form and content of these activities may vary. Further, not all of them are necessarily carried out during the standardization process (Schmidt and Werle, 1998).

During any of these steps, some or all actors may fail for a variety of reasons. The process spans several contexts that range from laboratories and R&D departments to marketing negotiations that deal with intellectual property rights, brand names and so forth. Thus standardization, through its promise to coordinate multiple activities that help move new ICT technologies successfully to markets, can erect vast arenas of coordination that need to connect a myriad of actors, artefacts and locations over time and space.

4.4 Concept of Open Innovation

Open Innovation is a term promoted by Henry Chesbrough, a professor and executive director at the Center for Open Innovation at Berkeley. The central idea behind open innovation is that in a world of widely distributed knowledge, companies cannot afford to rely entirely on their own research, but should instead buy or license processes or inventions (i.e., patents) from other companies. In addition, internal inventions not being used in a firm's business should be taken outside the company (e.g., through licensing, joint ventures, spin-offs).

Historically, technological innovation has been within the domain of in-house research and development (R&D) departments, where intellectual equity is created solely for in-house consumption. In this insular corporate model, the fruits of innovation are well-guarded resources for corporate differentiation, used primarily to keep an organization's product pipeline filled, get to market faster or drive down operational costs. Intellectual Property Rights (IPRs) generated through this type of "closed" innovation remain an internal resource, often with limited possibilities for further monetising these assets other than through technology licensing.

Matt Bross, BT's Chief Technology Officer, says that this insular viewpoint dictates that the quantity of innovation an organization can deliver correlates directly with the amount of resource invested. It also expresses that the number of new ideas that can be developed and brought to the market, in other words the breadth of the innovation pipeline, is ultimately constrained by the size and wealth of a company R&D department.

Actually, 20th century industrial models of R&D-led product innovation are becoming increasingly marginalized by market forces (Radjou, 2006). High levels of investment are no guarantee of commercial success when fickle customers can switch to an alternative product without warning. Similarly, in tightly regulated industries such as pharmaceuticals, there is a high probability that any given candidate product will fail to make it from lab to supermarket shelf, for scientific, safety or market reasons. As a result, risk must be carefully managed lest enormous development investment become effectively worthless overnight.

The impact of technology-focused innovation is becoming commoditised in today's fast-moving and often unpredictable global economy. Market advantage, expressed through the launch of a new product, loses much of its attraction when its technological capabilities can be rapidly cloned or reverse engineered. Matt Bross explains: "rather than years or months, the window of opportunity for a new product innovation to carve out an appreciate market niche may be as short as weeks or even days. We need to innovate at the speed of life. There should be no gap between what customers want and what organizations can deliver" (Bross, 2006).

Actually, a new approach of innovation is emerging. New technological ideas are being developed by commercial and academic entities globally. These more dispersed, dynamic innovation networks are also reflected in the rise of on-line marketplaces and the increasing of the entrepreneurship culture. Several start-ups have been created inside the universities and R&D laboratories.

Globalization has largely been driven by the increased ease and ubiquity of communications. For example, the development of the Internet and the IP networks that underpin it, have completely transformed the telecom industry. Previously we had a small number of very large, vertically integrated suppliers that provided everything. Today, when a telecom company has a specific technology need, the chances are that there's a start-up somewhere in the world trying to address its problem (Bross, 2006).

Corporate innovation, as a consequence, is opening its doors to the world. An increasing number of organizations are adopting a more pragmatic approach to delivering long-term stakeholder value from a "closed" innovation philosophy with one that's popularly referred to as "open innovation".

While precise definition vary, "open innovation" effectively means that organizations can draw on external resources and best practices to complement the value of their "internal" innovation assets and achieve greater real returns on their overall investment in innovation. Crucially, new products aren't the only tangible manifestation of open innovation. Service and process transformation are equally important facets of open innovation, whether it's to create an enhanced customer experience, to support internal business efficiencies or to support new products and services in their path to market.

Open innovation by no means negates the importance of internal R&D departments. Indeed, it multiplies the value of internal research and development budgets by exploiting external partnerships at every stage of the process, from scientific research to technological realization and product development. Similarly, to succeed in this new environment, companies need both deep skills to lead and interpret the opportunities in their innovation networks, and broad and flexible skills to engage with customer needs, assimilate new capabilities and execute.

In this open model, innovation becomes the common currency of an organization, its customers and its suppliers. This resonates with the Open Source movement, where end-users play an intrinsic role in the development of new software products. This increased input of the customer contrasts dramatically with traditional R&D models, where innovation flows in one direction, from lab to store shelf.

4.5 Impact of Open Source Software

4.5.1 Introduction to Open Source

Development model of Open Source software

The basic idea behind Open Source software is very simple. When programmers can read, redistribute, and modify the software's source code, it evolves. Programmers all over the world can improve the program, adapt it to their personal needs and fix bugs. The experiences of the past years show that this can happen at a speed, which compared to the pace of traditional software development, is really much faster. People who are familiar with Open Source software have learned that this rapid evolutionary process produces better

software than the conventional closed model, in which only the original programmers can see the source code and everybody else must use a so-called “black box” of bits. Because of the independent peer review and continuous evolutionary improvement and selection, Open Source software can reach levels of reliability, power and general maturity in short time frames that closed products will find hard to attain (EURESCOM, 2001).

Several attempts have been made to explain this phenomenon. One of the first and most popular studies in this field was Eric Raymond’s “Cathedral and the Bazaar” published in 1998. Some of Raymond’s ideas concerning the successful development of Open Source software will be presented here. The base of Raymond’s study is the assumption that two different categories of software development exist; they are then analyzed and compared. One development category is called “Cathedral-like development”. It is characterized by a centralized management and a strong control on design and implementation. Everything is well organized and planned in detail. This cathedral-like concept is typical for the development of proprietary software. The other development category, so-called “Bazaar-like development”, is characterized by informal communication between programmers. Every programmer implements or improves parts of the code and offers it to the others. The programmers are in contact via private e-mail and join together for the purpose of coordinating their changes. A mailing list and shared information space for the core developers participating in a certain project are created. The primary method of communication is the mailing list. The discussion is about new features, bug fixes, user problems, developments in the Open Source community, etc. The code development takes place on the developer’s local machines. New patches or improved source code are then posted to the mailing list and/or published on the appropriate webpage. Everyone can then choose the modules he wants, just like a bazaar.

The cathedral-like development is the traditional style of software management, although it is also used by some Open Source projects. In this model, there is a strong control on who can submit patches to the code, and on how they are integrated. Furthermore, in the cathedral-like structure the software development is totally adjusted to a stringent plan for code releases. On the other hand, the bazaar-style is not governed by a plan for code releases. A long-standing version for general use is released from time to time. Additionally, the programmers permanently add new features or improve and correct existing parts, so that there is a great number of rapidly evolving development versions, which are widely distributed and can be tested by interested programmers and users. This self-determined way of software development has a very positive influence on the programmers’ motivation. The success of the project is totally based on their ideas and their involvement, and every user can admire their refined source code. If enough people join such a bazaar-like process, it can lead to an exponential improvement and development of software. On the other hand, a software project dies if there is a lack of interest in the programming community.

Both cases can be considered as extremes in a continuum of software development models. While Open Source projects can be almost any model in that range, proprietary software project can hardly apply models different from the cathedral-like. Whereas the openness of the Internet makes it possible for innovation to come from everywhere, big companies have

difficulties gathering all necessary expertise on their teams. Furthermore each company only has a limited number of software developers at its disposal and its aim is to make a profit with its results. The important idea here is that Open Source software has allowed for the first time the introduction of successful alternative styles of software development that turned out to have a very positive influence on programmers' motivation and as a consequence on the quality of software products.

Another interesting point to look is about the driving forces that leads this community. In Annex C we can see the most important motivation factors for the developers' community of Open Source software.

Management in Open Source development

Despite the bazaar like development model, which is widely used in the Open Source area, Open Source projects do not propagate anarchic software development. In spite of using and benefiting from the very rapid bazaar like development model, most Open Source projects have a well-organized management structure and strict rules concerning new releases. The most popular Open Source licenses like the GNU GPL are based on a copyright, owned by the implementers of the project's initial source code. The copyright owners and possibly some other experts, who were explicitly authorized by the copyright owners, act as "benevolent dictators" for the Open Source project. The term "benevolent dictator" means a person or group that has the sole right to publish new releases and that nobody is allowed to insert bug fixes, modifications, extensions or new functionality to the project's official source code without the explicit permission of the benevolent dictator. However, every contribution, which helps the project's progression, is gratefully accepted. The most well know example of this way of managing Open Source development is the Linux project. Linux is a registered trademark of its creator Linus Torvalds, who now acts as benevolent dictator for the Linux project. Although many Linux developers from all over the world are permanently contributing patches to the project, the release policy is well organized (EURESCOM, 2001). The experience and success of the Open Source projects, which are managed in this way, show that this concept works well. It combines the advantages of the Open Source properties and the bazaar like development model on the one side with the strong desire of the creator and initial implementer to somehow control the further development of the project on the other side. The possibility of acting as benevolent dictator may also be an important impetus for companies that are deciding to release some of their software as Open Source.

Open Source licenses

It's commonly accepted inside the Open Source community that Open Source licenses can be divided into two categories: copyleft and unrestricted.

Copyleft is a term used by the FSF to label a certain class of licenses. Copyleft extends the copyright of a program with distribution terms that "give everyone the right to use, modify, and redistribute the program's code or any program derived from it but only if the distribution terms are unchanged" (GNU.org, 2007). This is the essence of copyleft: you may redistribute code based on a copyleft license, but only if you do this under the same terms and conditions (i.e., the same license). In this way the FSF ensures that the user's freedom is

maintained throughout the lifetime of the code by ensuring that all code remains open. The two standard copyleft licenses are the GNU Public License (GPL) and the Lesser GNU Public License (LGPL). The LGPL is “less copyleft” than the GPL in that it permits linking with non-free software modules.

Unrestricted is a term used for the less restrictive licenses advocated by the OSI. These licenses do not require derivatives of the licensed software to be released under the same terms and conditions as the original. It is possible, for example, to release a binary only derivative of such software. The two standard unrestricted licenses are the Berkeley Software Distribution (BSD) and Massachusetts Institute of Technology (MIT) licenses.

The GPL, LGPL, BSD and MIT licenses are generally regarded as the core Open Source licenses; all four are accredited by both the OSI and the FSF, although the FSF tries to promote the copyleft principle through advocating the GPL and LGPL.

There are many other Open Source licenses in use, although most of the successful Open Source software products use one of the four main licenses or a slight variation thereof. For example, the Apache license takes the BSD-style Open Source model and extends it by allowing check-ins to the core codebase by external parties.

In annex B we can look in the more detail to the most important features of the most important Open Source licenses presented above. In Annex D we show the most important arguments against the copyleft licensing model and proprietary licensing models.

Software Patents

Another controversial issue within the Open Source debate is that of patenting. The question is being whether it is “ethical” to patent a piece of software, thus legally stopping other developers from using an idea or a technique in their work without permission from the patent holders.

It’s also important to realize the difference between patents and copyright. Patents do not cover specific systems, instead, they cover particular techniques that can be used to build systems, or particular features that systems can offer. Once a technique or feature is patented, it may not be used in a system without the permission of the patent-holder, even if it is implemented in a different way. Since a computer program typically uses many techniques and provides many features, it can infringe many patents at once. The patent holders can license others to use the invention, but may also refuse to do so. Independent reinvention of the same technique by others does not give them the right to use it.

On the other hand, copyright is a legal device that gives the creator of a work of art or literature, or a work that conveys information or ideas, such as software, the right to control how that work is used. It is thus fundamentally different from a patent: it applies to a particular work, not to an idea.

Until recently, patents were not used in the software field. Software developers copyrighted individual programs or made them trade secrets. Copyright was traditionally understood to cover the implementation details of a particular program; it did not cover the features of the

program or the general methods used. And trade secrecy, by definition, could not prohibit any development work by someone who did not know the secret.

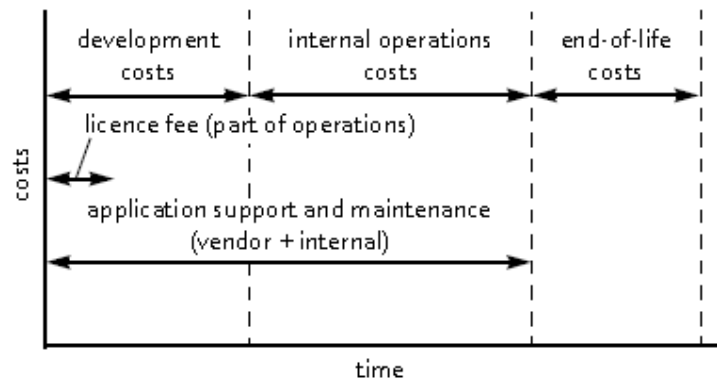
The introduction of software patents in the US and Japan has changed all that, and this practice is a commonplace in these countries, but is as yet not allowed in the European Union. According to the advocates of Open Source software this is the way it should be, as patents limit the freedom to develop Open Source software (nosoftwarepatents.com, 2007). The European Member states are currently reviewing their stance on software patents. For the moment however, the EU member states have decided recently to keep the ban on software patents part of the European Patent Convention. Recently, the Software Patent Directive was rejected by the European Parliament on the 6th of July 2005.

Costs of OSS

Total cost of ownership for an information system is complex, involving not just acquisition and deployment costs but costs for support, training, skills development, disruption during migration and staff churn. The software costs for an individual software component can broadly be broken down into:

- Software selection, acquisition and capital costs;
- Development, integration and customization;
- Operations, and application support and maintenance;
- End-of-life costs.

Figure 33: Costs of providing an OSS



Source: Bruce, 2005

Typically, a company will go to considerable effort in procurement to find the right software for each OSS applications, which may include request for proposal, draft architecture and fit with existing OSS, and test development work. There is a cost associated with this activity, and it will typically be higher cost for Open Source, due to the wide range of components available in the Open Source market. In the life of an OSS, the cost of development and integration can exceed the cost of the acquisition by many times. On the same way, the costs of operation and maintenance of OSS solutions includes the percentage of recurring annual licenses fee attributable to software maintenance, plus the effort in maintaining software. The research study conducted by Bruce in 2005 estimates that development costs of OSS can

reach ten times the acquisition cost or more (for a platform requiring a high degree of customization and integration with other OSS), and the operation/maintenance costs of OSS can be four times more than the acquisition fees (Bruce, 2005). Finally the end of life costs cover the decommissioning process and are assumed to be equivalents for Open Source and Custom-Off-The-Shelf (COTS) products.

The same study conducted by Bruce in 2005 estimates that a telecommunications company could anticipate an average saving of around 8% over the total life of the OSS, when considering all software, hardware, and operational related costs, and assuming mature Open Source for each area of the OSS software stack. Moreover, since most of the saving is up front on licenses, it would represent a much higher percentage of first year costs. Additional cost savings can also be made if Open Source components can be used out-of-the-box for product or service with less demanding OSS requirements, if Open Source components comply with open standard interfaces, and if Open Source operating systems extend hardware choice to stable originating lower cost of hardware.

In Annex E, we present in more detail the total costs of ownership of OS solutions.

Advantages and Disadvantages

There are many different reasons for using and developing Open Source software, ranging from philosophical and ethical convictions to pragmatic and economic decisions. The main practical and economic advantages of Open Source software are as follows:

- Development and quality – the development of the software as well as the detection and correction of bugs takes place at a quick pace. The software is generally of very good quality because many excellent programmers are attracted by Open Source projects;
- Reliability and integrity – the code is of very high reliability and integrity because it can be reviewed and improved independently. This reduces the chances of so-called Trojan horse being hidden in the code;
- Stability – Open Source products have been proven to be much more stable than their proprietary counterparts, as was shown, for instance, by scientific analyzes carried out by the Computer Science Department of the University of Wisconsin/MA (Vogel, 2001);
- Vendor independence and cost reduction – due to the availability of the source code and the freedom to redistribute the software, the user is not dependent on a single software vendor and, as such, benefits from significant savings on licensing costs and liberty of choice;
- Platform independence – the availability of the source code facilitates portability to different hardware platforms and the potential to rapidly adapt to changing conditions;
- Support service – the support offered by mailing lists and newsgroups has been shown to be very fast and of high quality. For users who prefer the more traditional commercial support, there are many companies that offer complete solutions and supported distributions of the best-known Open Source products;

- Growing popularity – Open Source products are gaining a rising popularity among users, an increasing market for support services and customization and enjoy a growing attraction for software developers and consultants.

On the other hand, the Open Source concept also has negative aspects, which have to be considered:

- There is no guarantee that development will happen until the project reaches a kind of self-sustaining level. This problem of an initial gap might be solved or at least reduced by the strong backing of one or more big companies. On the other hand the involvement of big companies might keep away some of the idealistic Open Source programmers from joining the project because they only want to work for their ideals and ideologies and not for a big company, which is interested in making profit;
- In the past, most of the Open Source products did not have the service and support structures which the users were familiar with the commercial software products. Open Source projects did have mailings lists and/or newsgroups for support, but many users were not used to this kind of support and did not trust it. Since people's experience over the past years have shown that, usually, questions are answered much faster and problems are solved more rapidly by the participants of such a mailing list or newsgroup than by a commercial software vendor, the situation is changing. More and more people rely on this new kind of support. Additionally, over the last few years various support companies have been founded which offer support services similar to the commercial software vendors. This has resulted in the traditional lack of support for Open Source products slowly disappearing;
- The motivation for improving and developing an Open Source product might vanish or at least decrease if the product manages to replace proprietary software and gain a position as market leader. On the other hand, this can also have the opposite effect, i.e., the situation might persuade the proprietary software vendor to contribute the source code of some of his products to the Open Source movement;
- There may be significant problems concerning intellectual property rights and software patents because the availability of the source code simplifies the detection of patent infringements by patent holders;
- Enterprises that embrace Open Source by adapting it into specific internal needs with in-house development, may run into serious problems when employers leave the company and take their firsthand understanding of those developments with them. But actually, this problem also arises in the area of proprietary software development. In that area it is even worse because of the source code is closed there is no possibility of finding a new employee who is already familiar with the software's code.

Each company has to weigh up the positive and negative aspects of the use and/or the development of Open Source software in the long run. However, the rapid spread of Open Source in the last few years does indicate that Open Source software will, at least in some areas, start to replace the currently common proprietary software products. More and more companies, such as *IBM*, *AT&T* and *Alcatel*, have adopted Open Source at different levels of

commitments and have integrated the Open Source model into their business concept (Vogel, 2001).

4.5.2 Open Source Business Models

During the last years several business models have been established with respect to Open Source software. In the following, some of the most important models will be presented and related to companies that work according to these models. These examples show that Open Source and business are not in contrast to each other, as many people believe. It is possible to make business and earn money with Open Source. Even more, in the future it might be difficult, at least in the area of operating systems and server solutions, to have economic success with proprietary software. The fact that the European commission and many national governments, such as those of France, Germany, Italy, the USA and China, as well as some leading market research institutes have issued policy documents on the Open Source movement, is forcing software companies to think about business opportunities offered by the Open Source model. Here we describe the most important and recent Open Source business models.

Support Service Provider Model

In this model, a company (effectively) gives away the software product, but earns money by selling the distribution and offering support, after-sales services, courses, etc.

One of the most popular companies in this field is *Red Hat*, which was founded in 1994 and floated on the stock market in 1999 (Nasdaq: RHAT). *Red Hat* is the leading provider of Open Source Internet infrastructure solutions, ranging from small-embedded devices to high availability clusters and web serving. *Red Hat* shares all its software freely with the Open Source community under the GNU general public license (GPL).

Among other Open Source software products, *Red Hat* sells various Linux distributions. The official Red Hat Linux OS and related services are available directly from the company or through its partners, which include top PC and server manufacturers such as *Compaq*, *Dell*, *Gateway*, *IBM*, *Hewlett-Packard* and *Silicon Graphics*. Each Red Hat Linux distribution includes special support packages, e.g., priority online access to software updates for a certain time (30 to 180 days, depending on the distribution) and telephone and/or email-based installation support for 30 to 90 days. They also sell a couple of further and more extensive support packages for their software distributions, which address different kinds of users. Furthermore, Red Hat offers training and certification programs on Linux, Open Source software in general, diverse tools and programming languages (RedHat.com, 2007).

Last but not least, what seems to become a very successful area of Red Hat's business at the moment is the provision of engineering services for a broad range of Open Source technologies to the world's leading software and semiconductor companies. These services include porting, optimizations, engineering development of new functionalities, and hardware and software certification.

In summary, it can be said that *Red Hat* is an exemplary company which has proven that the business model of a support seller works and that it is possible to have commercial success and make money with Open Source in that way.

Cost Reducers Model

Another business model related to Open Source software is characterized by the aim of reducing costs. In this model Open Source software is not used in order to make profit directly, but to reduce software related costs. For most of the proprietary software products the user has to pay high per-copy fees. Since he has to use the software as a black box, he completely depends on the company which produces this product exclusively. This usually leads to the fact that the user has to buy the support of that software company which is, due to the lack of competition, not only expensive but also often very slow and of poor quality. Furthermore, the user often has to buy another distribution for different hardware. Altogether, the dependency from proprietary software produces huge costs and little comfort.

With Open Source software the situation is completely different. The charge for an Open Source software distribution is very low because there are competing providers. Furthermore there are no per-copy fees because it is permitted to duplicate the program as often as needed. Since the source code of the software is available, the user has several possibilities for getting support. He can either ask any person who is familiar with the software product, he can get free support from one of the related newsgroups or he can buy the inexpensive and for the most part very quick and competent support from one of the above mentioned support service providers. Additionally, the availability of the source code also prevents the user from having to buy a new distribution if he wants to change his hardware. He can just adapt the existing software to the new conditions.

Motivated by the urgent necessity to reduce costs the European Commission and some national European governments namely the Germany, France and Italy, recently discovered Open Source software as a possible instrument for cutting down software expenses. The *Information Society Directorate General of the European Commission* recommends the promotion of Open Source software in several categories, e.g., in technical issues, organization and support, legal issues, etc. The European commission should take measures to accelerate the adoption process of Open Source software by European companies, organizations and individuals so that Europe does not miss this important development in the information society (conecta.it, 2007).

Widget Frosting Model

A business model, which is somehow related to the cost reducers as well as to the support service provider model, is Widget Frosting. In this model, a hardware company starts using Open Source software. For hardware companies software is a necessary adjunct, but strictly a centre of cost rather than of profit. Open Source is very suitable for reducing software costs enormously while at the same time being of higher quality and reliability than proprietary products. For that reasons several hardware companies have decided to switch to Open Source in order to get better drivers and interface tools at a lower cost.

Silicon Graphics, for example, have started to support and ship Samba by introducing Samba for IRIX, which is a supported version of the Open Source product Samba. *Silicon Graphics*

decided to use Samba because it is the most widely used and most reliable software for serving files via the SMB/CIFS protocol from Unix. In order to have the additional possibility of making money with Samba, *Silicon Graphics* created the supported Samba for IRIX distribution, which is now sold as standard software together with their hardware (SGI.com, 2007).

The idea of widget frosting is quite new and this business model has yet not led to great commercial success. Nevertheless, many people from the Open Source community, e.g., the OSI, believe that the clearest near-term gains in Open Source will be in widget frosting because more and more hardware companies are going to reject proprietary software and introduce Open Source software instead.

Proprietary Software Promotion Model

The Proprietary Software Promotion Model is another very interesting business model, which was recently introduced by *AT&T*. In this model, a company goes partially Open Source in order to promote their proprietary software products. The company releases a special distribution of a software product as Open Source. The special feature of this Open Source distribution is that some of the core modules and patches are replaced by older, worse or less efficient versions. For this purpose, the company has to use a special Open Source licence, which allows the company to use the same source code or parts of it in addition to their proprietary software.

The business strategy of this Open Source model is as follows. A company gives away those parts of their source code, which are no longer competitive because better solutions are already available. With these subtle tactics a company can reach three aims. First of all, it hopes to benefit from the Open Source community's ideas, improvements, bug fixing, etc. Secondly, this is the best possibility of establishing a certain software product as standard software. As a consequence, the company can presume that a lot of their Open Source users will not be satisfied with the weaker Open Source product for the long run and buy the higher quality proprietary software product (conecta.it, 2007).

Technology Promotion Model

A quite similar business model recently appeared in different software areas. Analogous to the Proprietary Software Promotion model, a company which follows the Technology Promotion model goes Open Source in order to promote its technology. But in contrast to the previous model, a company in this case releases its entire software related to a specific area and not only an old or restricted version of it. With this step the company expects to profit by selling more hardware, software components in related areas and support services.

This idea is the basic for *HP's* as well as for Sun's Java involvement (HP.com, 2007). The Technology Promotion Model was also introduced in the telecommunications area by *Natural Microsystems*, which has initiated the Open Telecom Project and created the opentelecom.org web pages (nmscommunications.org). The Open Telecom Project is dedicated to evolving and extending the telecom software infrastructure and porting this software to additional products and systems. The initial goal of the Open Telecom Project is to provide hot-swap and telecom circuit switching software for telecommunications equipment built for the

CompactPCI Computer Telephony Specification which was developed by the *PCI Industrial Computer Manufactures Group*. It provides for a rear panel telecom bus (the H.110 CT Bus), common telephony I/O definitions and reliable hot-swap of CT boards and peripherals, as well as agency-aware safety recommendations. The Open Telecom web site contains the entire source code for the software infrastructure that supports both hot-swap and telecom circuit switching in a CompactPCI system, released by *Natural MicroSystems*.

With this Open Source offensive *Natural MicroSystems* tries to drive growth in the CompactPCI industry. They expect the developers of telecommunications equipment and services will experience an increasing demand for CompactPCI hardware, software components and support services. As a consequence Natural Microsystems hopes to leverage its leading position as a CompactPCI board supplier in a considerably large and fast growing market as a result of Open Source software availability.

Development Broker Model

This business model is based on the fact that many companies, which want to use and adapt Open Source software for their own purposes, neither like to depend on the bazaar-like development model or have enough excellent programmers among their employees who could do the work.

In order to close this gap, Internet marketplaces like SourceForge, which is a registered trademark of VA Linux Systems, and *CollabNet* were founded. SourceForge offers a playground for developers to start a project for Open Source software development or improvements. SourceForge offers memory space to save the program code of new software, a system to keep track of the versions, a platform for developers to centralize their communication and their project management, a test environment, and, of course, a site to make the different versions available via the Internet. The code of the software is always available and most of the time the software is free to download. On the other side, *CollabNet* acted as a kind of broker in the Open Source community. Their SourceXchange marketplace was an Internet-based exchange that brings companies in contact with a global network of talented Open Source Developers. SourceXChange was a place where companies can bring their software projects and programmers can find interesting work. SourceXchange features included milestones, independent peer review of the developed code by Open Source community and thus high quality software, skills inventory and rating systems for developers and of course code reuse from the Open Software community which helps to lower development costs. With this model, *CollabNet* tried to manage to combine the advantages of Open Source software with traditionally planned software development.

Unfortunately, this project was cancelled in April of 2001, due to the lack of companies that were interested to pay for these services. However, the basic ideas of this project were recently reopened by other company, *OpenSourceXperts*, which is located in Germany. The idea of this company is to extend the original idea of SourceXChange and turn it more ambitious, embracing this concept to a larger number of projects, that can create a more enthusiastic feeling inside the international business market.

Developer License Model

Another very interesting business model is the Developer Licence Model which, for example, is used by Object Oriented Concepts, Inc. (OOC). OOC was founded in 1996 to provide CORBA compliant middleware. This software is commercialized under a novel licensing model.

For individuals, non-commercial use the source code of the software is free of charge and distributed under the ORBacus Royalty Free Public licence. This license allows the user to adopt the program to his personal use and to redistribute the original as well as the modified software if, and this is the decisive restriction, all these activities are non-commercial (OMG.org, 2007).

If the software is used in connection with the user's business, he has to buy either a run-time or a developer licence. As the term implies, the run-time licence only allows the licence to run the program whereas the developer licence also includes the right to modify the source code. However, the user is not allowed to redistribute the software. If he is interested in sharing his improvements with other users, he has to submit his modifications to OOC and ask them for insertion into the original source code. This shows clearly, that this developer license is not an Open Source licence in the same of the OSI certification mark, but is a clever way of combining the distributions with per-copy fees (similar to conventional software companies) while at the same time having the possibility of benefiting from users' improvements and modifications.

Sponsoring Technology Model

The Sponsoring Technology Model is not a business model in classical sense of the word since the *Apache group*, which introduced this model, is not interested in earning money with it. The Sponsoring Technology Model shall guarantee the further development and improvement of the Apache HTTP Server and other related projects. In February 1995, the public domain HTTP daemon developed at NCSA by Rob McCool was released and some webmasters started making their own extensions and bug fixes. A small group of these webmasters joined together in order to coordinate their changes. So in the beginning, the developers were actually the users who definitely knew the needs of a HTTP server better than anyone else. As a result of their efforts Apache 1.0, which was a product that covered their needs, was released some months later. The success was impressive because less than a year after the group was formed, the Apache server became the number one server on the Internet (apache.org, 2007).

In order to join forces and create a better environment for organising and promoting the further development of Apache and related software, the *Apache Software Foundation* (ASF) was founded in June of 1999. The ASF provides organizational, legal and financial support for the Apache Open Source software projects. The foundation is a membership-based, not-for-profit corporation and the business model behind it is to use the success of the Apache HTTP Server for winning sponsors and contributors for the ASF's Open Software projects. Big companies, like IBM and SUN, sponsor some of the ASF projects, because Apache is the market leader in the segment of web servers and the companies hope to benefit from further

developments in this area. In addition, they expect an increasing deployment and acceptance for their related products, such as IBM's WebSphere Application Server.

Loss Leaders Model

This business model has already been working very successfully for several years. In this model Open Source software is given away as a loss leader in order to put additionally proprietary software on the market.

This is roughly what *Netscape* is doing. They offer various versions of the Netscape Internet browser free of charge. Additionally, Netscape offers a wide range of business and consumer channels for professionals and consumers who use the site as central point for getting current news and information on areas of interest. *Netscape's* more than 30 million registered members use this Netcenter regularly to check their personalized information and access their email. This audience makes the site an attractive and effective buy for advertisers and marketers and *Netscape* earns most of its money in this area. In order to preserve the success of this advertising business, *Netscape* concentrates on keeping a market leading position, which guarantees high incomes from advertisements. For this reason, *Netscape* recently started some partner programs, which are expected to help spread Netscape's products. The fact that *Netscape* stock has maintained a solid position on the markets for more than five years now shows that this business model can be very profitable.

Effective Advertising Model

This business model aims to improve the public reputation of a company. In this model, a company, the main business of which is not selling software, releases internally used software as Open Source. If the software is not competitively relevant, the company loses nothing by publishing its source code. However, since the current level of media attention for Open Source products is very high, releasing Open Source software seems to be an excellent opportunity for getting free publicity and for improving the company image.

An example of the technology promotion mentioned above was recently introduced into the telecommunications area by *Ericsson*. During the 1980s an internal project at the *Ericsson Computer Science Laboratory* aimed to find out which aspects of computer languages made it easier to program telecommunications systems. The programming language Erlang, the syntax of which is similar to Prolog, was the result of this project at the end of the 80s. Erlang was created by taking those features which made writing of telecommunications systems simpler and avoiding those which made them more complex or error prone. Erlang is particularly suitable for distributed soft real-time concurrent systems. It was designed especially for use in telecommunications applications, e.g., handling mobility in a mobile network or providing unified messaging (Ericsson.com, 2007).

Recently, *Ericsson* decided to publish the source code of Erlang. Since the core business of Ericsson relies on telecommunications products and not on selling software, they had nothing to lose. It was expected that the release of Erlang as Open Source would have a positive advertising effect. However, the advertising success has been marginal, because Erlang is not well known in the telecommunications area. Nevertheless, Ericsson have benefited from the

Open Source release in other ways, because some programmers have started to fix bugs thus improving the quality of Erlang.

Accessorizing Model

One of the most simple business models concerning Open Source is the Accessorizing model. This model can be trivialized by selling items such as Linux penguin dolls, Open Source T-Shirts or cups. It is not quite clear whether the sale of this kind of accessories will lead an economic success.

However, the sale of books on the various Open Source products is undoubtedly a lucrative business. Companies like *O'Reilly Associates* and *JSC* are famous and successful examples in this business area (O'Reilly, 2007). Both companies are mainly devoted to selling books on Open Source software.

Individual Promotion Model

In many cases, the motivation that drives many people in the Open Source community is getting the recognition of peers. To be known as the person who found and fixed an elusive bug, or who donated a particularly clever piece of code is enough reward for many people. Typically, anyone who contributes to the code is usually acknowledged within the code as well as on a Web site. If it seems unlikely that some people participate in the Open Source community solely for the purpose of being recognized as a contributor to a major package, it must be kept in mind that there are advantages to being on a software contribution list. Being listed amongst the bug fixes or feature donators is résumé material, and useful for drumming up custom programming, consulting, and support business. Sometimes it even becomes a race to see who can do it first and best.

Start-up Company Promotion Model

Another model that is becoming very popular among start-up companies, usually associated with the so called “new economy”, is to start and sponsor an Open Source project and to donate some initial code to it. Two very successful companies which have used this Start-up Company Promotion Model are *Vovida Networks*, which provide their Vovida Open Communication Applications Library (VOCAL) as Open Source, and *Lutris*, which was founded as an Open Source enterprise software and services company (Vovida.org, 2007). Usually, such companies develop complete solutions and commercial product packages (e.g., soft switches and application servers) based on the Open Source software provided by the community they sponsor. This model is very good way of getting high quality products with reduced costs and in a short time. Additionally, the companies get free advertisement in the media and gain popularity in the rapidly expanding Open Source community, which is usually associated with the market where these companies operate.

4.5.3 Open Source Initiatives in Telecommunications

EURESCOM P1044 Project

The EURESCOM strategic study on “Aspects of Open Source in Telecommunications” (P1044) started in September 2000 and ended in January 2001. The participants in this project were: Deutsche Telecom AG, Eircom plc, Elisa Communications and Portugal Telecom S.A.

The project analyzed Open Source concepts and solutions from a telecommunications operator’s perspective. The results of the study show that the use of Open Source software is spreading very quickly, all over the existing technical fields used in the telecommunications industry, from server operating systems to application servers. The Open Source movement has started a silent revolution and many Open Source projects are being used to ride into traditionally closed source territories. The Open Source products Linux and Apache had both gained considerable market shares. Apache had already achieved market leading position and Linux was expected to become market leader within next years. Apart from these well-known Open Source products, many other very promising Open Source projects have been initiated during the last years.

The results of project P1044 intend to assist in the decision making procedures because the Open Source phenomenon was analyzed from a Public Network Operator (PNO) perspective.

The project investigated the phenomenon of Open Source software into three parts:

- Firstly, a look was taken at the business aspects of Open Source software. Some promising Open Source Business Models were analyzed and recommendations were made on how these models could be adopted in the telecom domain and integrated into PNO’s business strategies;
- Secondly, the legal aspects of Open Source software were described. Essential and noteworthy information and Open Source software licensing, warranty and patent were presented;
- Finally, essential technical aspects of various Open Source software products were presented. Detailed analyzes of various important telecom related Open Source products were carried out.

In summary, the results of Project P1044 have shown Open Source to be more than just a well known politically controversial topic. Open Source software has become a very successful alternative to traditional software in many areas, from both a technical and an economical point of view and should be included in all PNOs’ business strategies.

New Generation Operations Support Systems

The *Telemanagement Forum* (TMF) is the leading telecommunications industry body developing common standards for Telecommunications OSS. They are presently working on a set of standards called New Generation Operations Support Systems (NGOSS) for the management of next generation networks (Gallen and Reeve, 2006).

NGOSS is the industry's only true standard for development and deployment of easy-to-integrate, flexible, easy-to-manage OSS components (Simms, 2004). NGOSS defines, for service providers and their suppliers, a comprehensive integrated framework for developing, procuring and deploying operational and business support systems and software. NGOSS is provided as a set of documents that make up a toolkit of industry-accepted specifications and guidelines that cover key businesses and technical area, and a defined methodology for use with the tools. It uses a "lifecycle" approach to the development of management systems, based on clear definition of business processes, specification and architecting software and systems to automate those processes, and compliance of those systems against NGOSS test criteria.

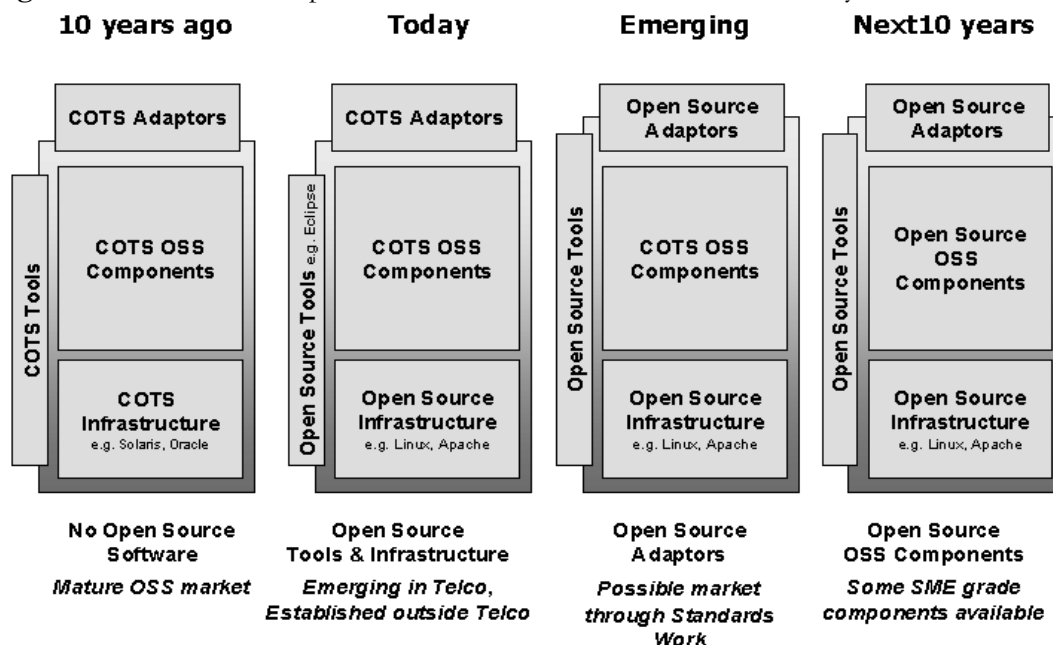
The aim of the NGOSS program is two-fold: to deliver a framework that will help produce New Generation OSS/BSS solutions, and to be a repository of documentation, patterns, models and code in support of these developments. In this context, "framework" means an architecture and methodology which can support business, system, and implementation views of Operations Support Systems (OSS) and Business Support Systems (BSS) component-based solutions. The goal of NGOSS is to facilitate the rapid development of flexible, low-cost-of-ownership OSS/BSS solutions to meet the business needs of the Internet-enabled economy.

NGOSS has four key components:

- SID – shared information and data model which describes the information shared by OSS systems used by a service provider;
- eTOM – extended Telecoms Operations Map which provides a framework to describe telecommunications business processes and how these processes use the OSS systems in a typical SP;
- Technology Neutral Architecture – the architecture does not define how to implement NGOSS, but rather what principles must be applied for a particular technology specific architecture to be NGOSS compliant. The Technology Neutral Architecture defines architectural principles to guide OSS developers to create OSS components that operate successfully in a distributed environment;
- Contract Interfaces – define an API for interfacing NGOSS components to each other across the architecture.

Unfortunately, while the industry has participated in defining NGOSS through the *Telemanagement Forum*, the standard has not yet been widely adopted in operational use. Because service providers are not yet specifying the use of NGOSS in new projects, ISV's have been slow to adapt their current products to the NGOSS architecture.

Figure 34 illustrates the status of Open Source in the telecommunications industry, which has historically been very conservative and slow to adopt the Open Source model.

Figure 34: The status of Open Source in the telecommunications industry

Source: Gallen and Reeve, 2006

Until 10 years ago all of the OSS infrastructure would have been either built using large in-house development teams or more recently bought in as Custom-Off-The-Shelf (COTS) products.

The emergence of the Internet and the ISP market place drove the commercial adoption of Open Source infrastructure components such as Linux and Apache. This has forced the telecommunications service provider community to at least evaluate the Open Source option for infrastructure components.

More recently, various groups have been proposing an “open source like” approach to sharing the development of common adaptors between established COTS components. This has been championed by the OSS through Java Initiative (OSS/J), which was established in 2000 by Sun and a number of OSS vendors. OSS/J has sought to embody NGOSS principles and provide a technology specific implementation of the technology neutral NGOSS architecture. In addition to the standards work, Open Source communities such as Tigerstripe are emerging for the tooling and sharing of OSS/J interfaces (Gallen and Reeve, 2006).

The OpenOSS Initiative

The OpenOSS initiative intends to provide a new and complementary route to expedite the realization of NGOSS and other open standards relevant to the OSS industry. It promotes, develops and maintains a collaborative Open Source environment, from which multiple business-driven projects can create, test and establish a toolkit of reusable NGOSS software components (Marcello, 2008). Furthermore, it wants to support the drive implementation of OSS standards. The objects of which would be to:

- Embrace the NGOSS approach to develop a “sandbox” of Open Source software;

- Make software and associated documentation freely available to the industry;
- Provide feedback on implementation experience into OSS standards activities;
- Provide a vehicle for research to engage with realistic service provider problems.

The development of a sandbox providing a modular OSS environment of Open Source software, Commercial Off-The-Shelf (COTS) packages and development software is key to the vision and fundamental to the stated objectives (British Telecommunications, 2005). To support this OSS portfolio, the sandbox will contain not only OSS functionality, but a variety of software, including enterprise software, such as application servers and databases, adaptors to OSS integration standards and development tools.

The OpenOSS initiative will not create any actual OSS standards; however, it is expected that the implementation of the sandbox will provide a vast amount of openly shared knowledge that can be used to provide feedback into the Telemanagement Forum (TMF) and TMF-related standards making activities, which will help further promote the uptake of OSS standards.

A sandbox has the potential to become a valuable tool for service providers to prototype and de-risk the management of new service offerings before going for tender products and for research into realistic service provider problems. For example, such prototyping could be done for managing services such as Voice over IP (VoIP), managing Business-to-Business (B2B) relationships, managing Business-to-Customer (B2C) self-service capabilities and managing access networks. With technological advances and transformations to converged digital networks comes dynamic and customisable service possibilities that, in turn, will demand equally dynamic and customisable management solutions. The sandbox thus also provides the potential to prototype these new Next Generation Network (NGN) management paradigms.

It is envisaged that this Open Source approach in the TMF context will help:

- Expedite the realization and deployment of NGOSS by service providers through the creation and sharing of NGOSS compliant adapters to OSS applications;
- Validate and provide feedback on standards through the encouragement of open collaboration (using the toolkit) to develop NGOSS implementations;
- Automate some of the NGOSS lifecycle processes through the open development of software tools (e.g., to create technology-specific realizations of the standards);
- Encourage the rationalization and reuse of common infrastructure components through the shared architecting and integration of common infrastructure components within NGOSS implementation.

Although having reached a level of maturity, the TMF NGOSS standards are still not in widespread use across the industry. Presently there are several perceived road blocks to adoption (Bruce, 2005).

Firstly, while OSS vendors have long-term plans for NGOSS adoption, they will only bring products to market when customers regularly begin to signal their requirements by specifying

NGOSS in Request for Proposal (RFPs). Customers will only begin specifying NGOSS when they are educated as to its value and are confident that a NGOSS based solution will work.

Secondly, the full acceptance of NGOSS can only be derived when many architectural components and tool support are in place. Early delivery of architectural components delivers limited value without the availability of other NGOSS components with which to integrate. Lack of experience or tooling for NGOSS processes mean that early adopters find the true flexibility and benefits of NGOSS hard to achieve. Greater acceptance of NGOSS can be encouraged by making it easier to deliver NGOSS components and by developing NGOSS lifecycle tools.

This problem of building market acceptance for emerging standards is not unique to the TMF. Often potential adopters are interested in the standards but do not have the time or resources to evaluate solutions themselves. Standards adoption can be accelerated by making it easier for potential users to evaluate and share experience using reference components. This can be further accelerated by facilitating the sharing of example solutions and worked examples. A more open and long-lived approach may speed the early adoption of the standards work. Sister standards bodies such as the Desktop Management Task Force (DMTF) are already proving the value of Open Source as a vehicle to perfect and disseminate their standards work to a wider audience. This could equally prove a valuable vehicle for promoting the uptake of TMF standards.

The OpenOSS project intends to have an important impact on the following stakeholders:

- Value contribution statements – this project will deliver to the industry a structured and controlled method that will enable the resolution of specific NGOSS challenges using the Open Source approach;
- Customer benefits – the potential benefits of NGOSS for the end customer will be in the following areas: service agility, more integrated customer “touch points”, sooner time-to-market of available capabilities and features, and an overall lower cost of operations can all be passed on the customer;
- Service provider benefits – service providers and system integrators have an interest in any move that accelerates the development of OSS integration standards and solutions, so as to tackle the current high OSS integration costs, complex integration issues and long lead times. The prospect of openly sharing and working on NGOSS adapters will accelerate this developments;
- Supplier benefits – the establishment of a toolkit and OSS testbeds could potentially bring immediate benefits for both COTS software vendors and equipment supplier. The concept of Open Source OSS or BSS applications in the Telco industry could be viewed as being in contention with the value-add of the established. Furthermore, it is envisaged that the COTS providers will share the development and use of NGOSS software components developed with a cross-industry perspective. It is well-known and confirmed that many COTS suppliers already use Open Source components in their product solutions. The OpenOSS project expands the opportunities to use additional components, which are specifically focused on NGOSS capabilities.

The project team of OpenOSS project identified some risks and the actions to be taken if such risks materialize (Bruce, 2005). Risks identification and mitigation are:

- The concept of using Open Source is a recent concept within the TMF. The TMF technical council is responsible for ensuring sufficient support from the NGOSS program. Implicit is that the TMF is able to agree upon licence arrangements that are acceptable to the OpenOSS team members and the TMF at large;
- The scope of this project is very ambitious and will require a high level of resource and commitment. The business cases will provide a cost-benefit analysis. Thereafter, individual team member organizations are responsible for generating sufficient interest to expand the project, e.g., Service Providers to engage with Vendors, all to engage with management teams;
- The project is dependent upon a large amount of Open Source software, and is also dependent upon a considerable amount of software development. The project will seek to use mature Open Source software, possibly, backed by professional support organizations. The Service Providers and Vendors are responsible for generating sufficient interest to provide software developers to resource the project, e.g., from Service Providers, Vendors and Universities to participate in demonstrations;
- The project will require ongoing commitment. The Service Providers are responsible for providing long-term steer and direction. The Vendors are responsible for integrating the project deliverables into their product roadmaps.

The OpenClovis Initiative

OpenClovis is a high tech start-up company founded in 2002 with the mission to provide communication system vendors with a suite of software infrastructure components, helping them to greatly reduce time-to-market, development risk and cost. OpenClovis Solutions is now the leading system infrastructure software platform provider to the communications industry, leveraging a notable communications systems expertise of the OpenClovis R&D team. OpenClovis Solutions is headquartered in Petaluma, California's Telecom Valley, with a substantial R&D facility in Bangalore India.

During the beginning of June of 2006, *Clovis Solutions, Inc.* announced it has launched a new Open Source project that aims to transform the telecommunications industry. The company launched with a new name, *OpenClovis* (previously *Clovis Solutions, Inc.*), and an Open Source business model with the OpenClovis Software Project, which made available more than 500,000 lines of its robust high availability and manageability code to the Open Source community. As an extension of its Open Source initiative, the company launched ClovisForge, an Open Source project that provides the high availability and carrier grade capabilities required by the telecommunications industry to popular Open Source enterprise and telecommunications applications.

In an interview, V.K. Budhraj, CEO and president of *OpenClovis*, clarified about the purposes of this project:

“We believe this bold initiative is necessary to stimulate growth in a market challenged by increased competition, demand for new services and continued economic pressures. Our goal is to extend all the benefits of Open Source to the telecommunications industry including faster time to market, lower costs, high reliability and greater choice” (Budhraj, 2006).

The OpenClovis Software Project will provide the industry with an extensive set of high quality, modular and reusable software components and tools that are standards-based and designed to be hardware and operating system agnostic. The project’s objective is to help network equipment vendors quickly and cost-effectively build platform manageability and high availability into their next generation communication systems.

The feedbacks received from the market have been very positive. We can confirm that by looking these 3 comments presented in the Networking magazine:

“The availability of an Open Source application service platform that addresses the requirements of the telecommunications industry is a major step that will accelerate industry adoption of open standards based building blocks solutions like AdvancedTCA. By putting its code into Open Source, *OpenClovis* will help create solid scalable, carrier-class software for next generation telecommunications networks” (Kober – director of Strategic Platform Planning at Intel, 2006).

“Going Open Source is a courageous move for *OpenClovis* but one that makes a great deal of sense. The telecommunications market is adopting standards-based hardware and operating systems, but there is still a question mark over standards from the middleware level and up” (Chappell – research analyst for Light Reading’s Services Software Insider, 2006).

“*OpenClovis*’ contribution marks a significant milestone in the industry’s adoption of Open Source and COTS to cut costs, reduce time-to-market and deliver differentiated value. Wind River looks forward to partnering with *OpenClovis* to help create a standards-based, open platform for highly available distributed telecommunications systems” (Seiler – manager of Linux Platforms at Wind River, 2006).

OpenClovis is also partnering with telecommunications industry leaders in the move toward highly available, interoperable and standard-based solutions. Several major corporations already support the OpenClovis Software Project to accelerate the industry shift to COTS hardware and software, including *AT&T*, *HP*, *IBM*, *Intel* and *Wind River*.

The *OpenClovis* saw revenues grow by over 200% in 2006. The introduction of the Open Source business model have been a tremendous success as experienced by their customers and partners, with more than 3500 downloads of OpenClovis Application Service Platform and more than 700 registrants in the Open Source community (Smith, 2007). This great performance was also a surprise to the CEO of *OpenClovis*: “Our 2006 performance, as measured by revenues, customer design wins and partnerships, exceeded every one of our targets” (Budhraj, 2007).

OpenClovis also introduced during the year of 2005, new versions of its commercial products, OpenClovis Application Service Platform and OpenClovis Integrated Development Environment, which are sold and supported under the dual GPL Open Source and commercial license model.

5 Emergent Technologies

5.1 Short Overview

In this chapter we make an overview of the most important technologies that are emerging in the telecommunication sector. These technologies were studied due to their impact in the business strategy of incumbent companies and their potentiality to facilitate the appearance of new players in the market. In a first instance (section 5.2) we look to the IPv6 protocol taking in consideration his addresses and layers, routing methodology and other improvements in the domain of security and quality of service. Consecutively (section 5.3) we look to the IMS architecture, introducing his layered model and his potentiality to be an enabler of convergence. Subsequently (section 5.4) we show the VoIP technology and we make a brief overview of his layers, protocols and issues of the quality of service. At last (section 5.5) we divulge the mobile ad hoc networks and we characterize their communications environment, their basic protocols and security features.

5.2 IPv6

5.2.1 IPv6 Addresses and Layers

The Internet is huge and ubiquitous and it has become a truly massive entity. The Internet is also in constant motion, growing and expanding at an unpredictable rate and in numerous technical directions. This growth is fuelled by the world's insatiable demand for instantaneous information, entertainment and communication. Left unchecked, this growth will continue to transform the once manageable Internet into an endless labyrinth of networks and computers. In fact, the advent of cellular Internet services will greatly exacerbate this problem. The potential infusion of half-a-billion new mobile Internet devices will finally break the current paradigms.

The world has nearly outgrown the current Internet, and cellular Internet devices will further expedite this process. A whole new Internet is needed. This new Internet must be built from the ground up. Like all new construction projects, the next generation of the Internet must be built upon a solid foundation. That foundation consists of a completely rewritten Internet Protocol (IP) known as IPv6.

IPv6 is designed, first and foremost, for scalability, but it also adds many other inherently useful communications features such as security, automatic configuration and expedited classes of traffic. Together, all of these features set the stage for a new and improved Internet.

The current version of the Internet Protocol is IPv4. IPv4 uses 32-bit binary addresses that are commonly converted to the familiar "dotted decimal" notation. The decimal representation of an IP address typically appears as 168.100.1.1. Since there are 32 bits in the address, simple binary arithmetic indicates that there are 2^{32} (approximately 4 billion) available addresses.

IPv4 was developed over 20 years ago. At that time, PCs were in their infancy, the planet's population was about 4.5 billion people, and it was inconceivable that the world would ever require more than 4 billion IP addresses. Unfortunately, those addresses were not allocated equitably. A large percentage of the IPv4 addresses were designated for special purposes. Furthermore, the early corporate and educational pioneers of the Internet such as MIT, Xerox and Apple each have more available addresses than the entire country of China.

IPv6 addresses are 128 bits long. In scientific notation, 2^{128} is approximately $3.4 * 10^{38}$ addresses, or $7 * 10^{28}$ addresses for each person on earth. In short, even with any allocation anomalies that may occur in the future, there is no way that all of the IPv6 addresses will ever be depleted. IPv6 addresses are represented in hexadecimal notation with colons as delimiters, so a typical address looks like this:

21DA:00D3:0000:2F3B:00AA:00FF:FE28:9C5A

There are some shortcuts available that can compress parts of this address, but in general, IPv6 addresses are quite long and unwieldy. The first few bits of an IPv6 address indicate the packet type. Unicast, multicast, broadcast and anycast (a new type) packets are fully supported by IPv6. The next portion of the address will then identify the network affiliation of that particular address.

The length of IPv6 addresses affords a high degree of flexibility when it comes to allocating and segmentation addresses. Several different proposals exist for dividing IPv6 addresses between network identifiers and host addresses. In most cases, at least the first 64 bits are reserved for network addresses, with the remaining bits containing the host address. In some cases, a device's existing IPv4 addresses or MAC (Ethernet) address can be embedded in the space designated for host identifiers. Each 128-bit address will be accompanied by a prefix length metric. This is directly analogous to an IPv4 subnet mask. The prefix length indicates how many bits (starting from the left-most portion of the address) will be used for the network portion of the address, while the remaining bits will identify the individual host computer's address. In order to build large and scalable networks, the IPv6 authors envisioned a hierarchical distribution of the network portion of the address to facilitate high levels of aggregation.

IPv6 is defined by the Internet Engineering Task Force (IETF) in RFC 2460. However, that is just the tip of a huge networking iceberg. Over 50 other RFCs define the features, capabilities and methodologies associated with IPv6. One of the most important ancillary features is the neighbour discovery process, specific in RFC 2461.

The neighbour discovery protocol (NDP) is designed to supplant the IPv4 address resolution protocol (ARP) and, in addition, to discovering the link-layer addresses of neighbours (which is the sole purpose of ARP). NDP also provides some other services like:

- Discover the local routers, instead of requiring the workstation administrator to explicitly configure default gateway addresses;
- Learn the network prefixes of devices.

NDP uses a revised version of the Internet Control Message Protocol (ICMP) for its protocol foundation. Neighbour solicitation and neighbour advertisement messages are used to detect and maintain neighbours relationships.

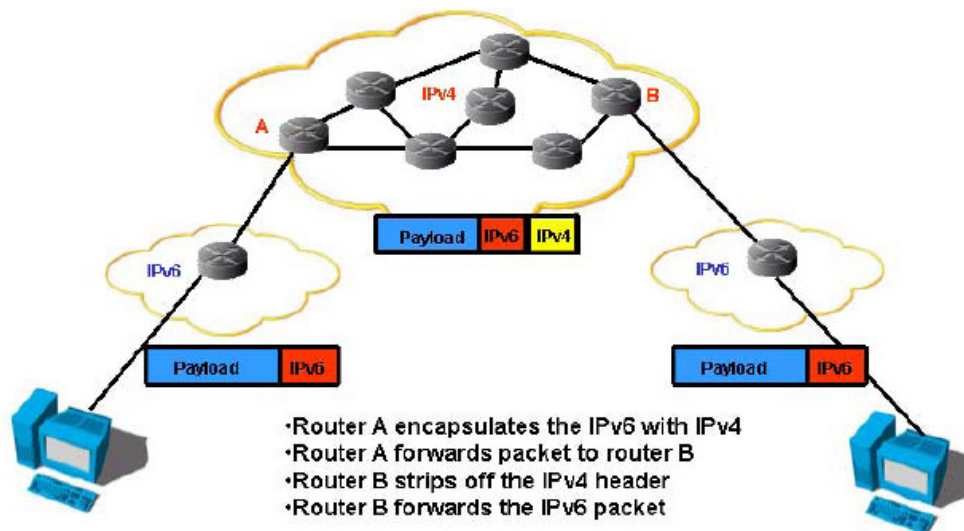
Similar to DHCP, the IPv6 auto-configuration procedure is used by workstations. Instead of using a server for address distribution, the IPv6 auto-configuration process is supported by a host's local router. The router will supply the workstation with an IP address, prefix and default router information. Both "stateful" and "stateless" auto-configuration methods are available, depending upon the level of control that the network administrator desires over the distributed addresses.

IPv6 is being implemented in phases, starting with small pockets of experimental networks. The overall transition of the Internet will take many years, perhaps a whole decade. During this prolonged period of time, both protocols will need to peacefully coexist and interoperate. Furthermore, all network resources must be accessible to users regardless of their version of IP. Several different mechanisms have been developed to support a transitional environment.

Various perspectives exist with regard to transactional methodologies. Encapsulation is one popular option. However, this is not necessarily a straightforward solution. There are some issues relating this question especially with the simultaneous existing of both protocols (Spirent Communications, 2004).

Protocol encapsulation or tunnelling is a simple concept, but it is dependent upon two underlying assumptions. First, two endpoints must be running a common version of IP (IPv6 in Figure 35). Second, the ingress and egress points of the intermediate network (IPv4 in this case) must be able to encapsulate, route and de-encapsulate the packets.

Figure 35: Network tunneling scenario



Source: Spirent Communications, 2004

The diagram in Figure 35 indicates a typical network tunnelling or encapsulation scenario. In this case, two remote "islands" of IPv6 must be interconnected over the legacy IPv4 Internet. The source device on the left generates an IPv6 packet, which is destined for the right-hand

workstation. At the entrance to the Internet (router “A”), an IPv4 header is added to the packet so that it can be routed using the traditional protocols. At the egress of the Internet (router “B”), the IPv4 header is removed, and a native IPv6 packet is delivered to the destination.

Most tunnels are typically created manually as part of the basic router configuration for devices at the edge of the networks. However, manual configuration is not a very scalable mechanism, so automatic tunnels will be necessary in the future. A standard known as “6to4” specifies an automatic encapsulation and tunnelling method. This specification includes a technique for mapping IPv4 addresses to IPv6 addresses.

Tunnels can be automatically propagated from a centralized tunnel broker, according to one proposal (RFC 3053). Another option that can be used in conjunction with 6to4 encapsulation is the Intra-Site Automatic Tunnel Addressing Protocol (ISATAP). This solution takes advantage of the auto-configuration facilities inherent in IPv6 to distribute the appropriate tunnel addresses.

Currently, the most common transitional mechanism is known as a dual stack implementation. This means that a workstation, server and/or router must support both versions of IP. Therefore, it will be able to communicate with IP networks regardless of the version. Unfortunately, the overhead associated with dual stack implementations is quite substantial. Hosts or routers will need twice the processing power and memory resources that a single protocol would require. These extra resource requirements can seriously tax the performance and scalability of the device.

The third type of transitional methodology is simple network translation. This involves placing a gateway (typically a software application on a local router) between an IPv4 network and an IPv6 network. This gateway will convert packets from one version of IP to the other. This is the most effective method for true any-to-any communications, which ensures that all network resources are fully accessible regardless of the version of IP being used. The most common type of translation is known as Network Address Translation – Protocol Translation (NAT-PT), which full specification can be accessed in RFC2766 reference.

5.2.2 IPv6 Routing

The Internet Protocol (IP) operates at layer 3, the network layer, of the well-known OSI communications model. By definition, the network layer requires routing. Network reachability is determined by one or more of several different routing protocols.

New routing protocols have not yet been developed for IPv6. Instead, all the major IP routing protocols (BGP, OSPF, RIP and ISIS) have modifications and extensions that allow them to support IPv6 networks and addresses. Over the years, these protocols have all been refined and optimized for IPv4 environments. These protocols all have extremely limited practical experience in IPv6 environments (in fact, most router vendors are only just completing their OSPF IPv6 solutions). The performance, scalability and functionality of legacy routing protocols in these new environments are not known.

The Border Gateway Protocol (BGP) is the routing protocol of the Internet. BGP is now in its fourth generation, so it is commonly referred to as BGP4. Since BGP was designed specifically for the Internet, it was built with scalability in mind. The current IPv4 Internet contains approximately 150,000 routes and BGP handles this size network very effectively.

In 1999, some new fields were added to BGP update packets to allow the protocol to support any atypical Internet communications requirements that might be developed. In particular, these new facilities, known as the multiprotocol extensions, were initially supposed to be used to support multicast routing. These new fields can also be used to propagate IPv6 addresses.

The Open Shortest Path First (OSPF) routing protocol is an interior gateway protocol, so it is typically used within a single autonomous system or administrative domain. As such, it is commonly found in large enterprise, academic or governmental organizations. OSPF version 2 is the prevalent version and it was designed specifically for IPv4 routes.

A new version of OSPF known as OSPFv3 was designed to support IPv6. OSPFv3 is very new in the industry and is not yet used in any major production networks. In general, OSPF is an extremely complex protocol, which contains different functions and descriptions for many types of routers, network links and advertisements. Although OSPFv3 is similar to its predecessor, the differences are substantial enough to cause one to assume that a lengthy shakeout period will be necessary for this complex reworked protocol.

The Routing Information Protocol (RIP) has several scalability and functionality limitations. Accordingly, it is not commonly used in large networks. However, even smaller RIP-based networks will eventually need to migrate to IPv6. Therefore RIPng (“next generation”) has been developed to advertise IPv6 addresses. RIPng was developed in 1997 and it was the first routing protocol to be modified for IPv6 support. RIP is a very simple protocol and the IPv6 extensions are equally straightforward.

ISIS is slowly gaining popularity in service provider networks and it has been modified to support IPv6. Again, the rate of deployment for ISISv6 is quite minimal.

Overall, there are several different routing solutions for IPv6. However, empiric experience with any of these IPv6 routing protocols is extremely minimal. The performance and scalability aspects are unknown. Furthermore, it is likely that these are only temporary band-aid style solutions. In the long term, a more practical solution will be the development of an entirely new routing protocol optimized specifically for IPv6.

5.2.3 Other IPv6 Developments

IPv6 promises many new features, all of which will incrementally improve the art of networking. Two of these features are data security and quality of service, which are discussed in the next sections.

Security

The world’s current geopolitical climate certainly punctuates the need for improved data security. Additionally, legislation, internal corporate requirements, and just plain common

sense also dictate stringent information security requirements. However, the Internet is the antithesis of a secure network and it is an entirely open public network. The architects of IPv6 have chosen to directly address this issue of Internet security.

IP security, commonly abbreviated as IPSec, is accomplished via encryption. The IPv6 encryption algorithms are identical to those used for IPv4. There are couple of different options for encryption types and levels, but in general, an end-to-end secure tunnel is constructed through the Internet. IPSec can be added, as needed, to some IPv4 routers, servers and workstations. Alternatively, a separate external tunnel server can also be used to initiate or terminate IPSec tunnels.

Instead of viewing IPSec as an adjunct function, IPv6 has built-in support for this secure protocol. A separate security extension header facilitates encryption and the associated key authentication. However, it is important to note that there is a significant trade-off that must take place in order to implement IPSec. The encryption and decryption functions (especially when 128-bit keys are used) require a lot of processing overhead and can seriously impact the performance and scalability of the associated devices.

Quality of Service

IPv6 provides a much more sophisticated quality of service mechanism than that of its predecessor. For starters, the IPv6 header contains an 8-bit traffic class field. This field can be mapped directly to the IPv4 type of service field. In short, this supports the same types of differentiated services as an IPv4 packet.

IPv6 augments the traffic class field with a 20-bit flow label field. Though the use of this field is not yet fully defined, the basic principle is quite intriguing. This label can be used to identify an end-to-end traffic flow, which would then, in theory, be assigned to a specific class of service. This could facilitate a deterministic end-to-end connection-oriented service through the connectionless Internet. This technique could substantially improve the quality of real-time audio and video applications.

The architects of IPv6 have gone to great lengths to ensure that it is a fully extensible and open protocol. Other new features can be added as they are developed in the future. The list of services that are supported by IPv6 can be expected to grow significantly over the coming years.

5.3 IMS

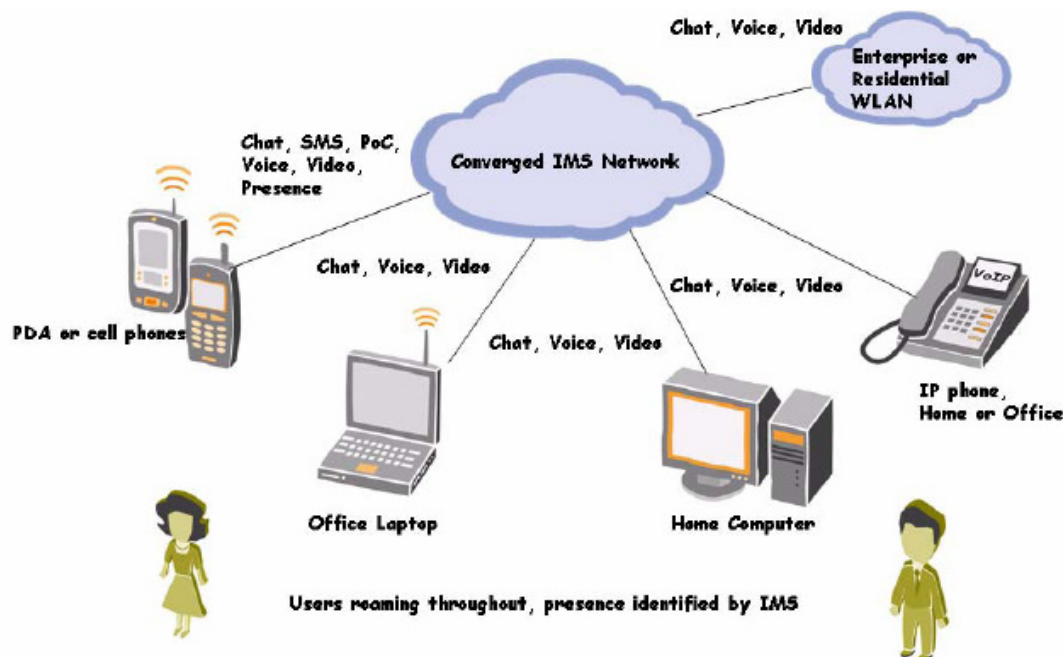
5.3.1 Introduction to IMS

The IP Multimedia Subsystem (IMS) is a flexible, packet-based network architecture that allows network operators to quickly and cost effectively introduce multimedia and other profitable new services into their portfolios. The use of IMS architecture simplifies network operations and allows providers to focus on service introduction and business opportunity. For example, an IMS architecture could allow fixed and mobile users to communicate using voice, video, chat and online gaming, and to take advantage of functionality such as Push to

Talk over Cellular (PoC), the ability to quickly arrange meeting through a walkie-talkie mechanism, Instant Messaging (IM) and Presence (whether and how a user is available and how the user wants to be contacted).

By itself, IMS does not specify any new service; rather, it provides a framework for network operators to build and launch their access-agnostic services. New applications, whether developed in-house or outsourced to third-party developers, can be integrated quickly into IMS because of the nature of the architecture.

Figure 36: A simplified IMS converged network (service focus)



Source: Sardella, 2006

The IMS specifications define the functions to handle the signalling and user traffic for multimedia applications. Although some of the diagrams can look daunting, the functions are separated into logical layers and many of the specified functions often reside in a single platform. Vendors have the flexibility to implement IMS functions in consolidated ways and processing functions, and routers will be able to take some of the session-enforcement and gateway functionality in IMS.

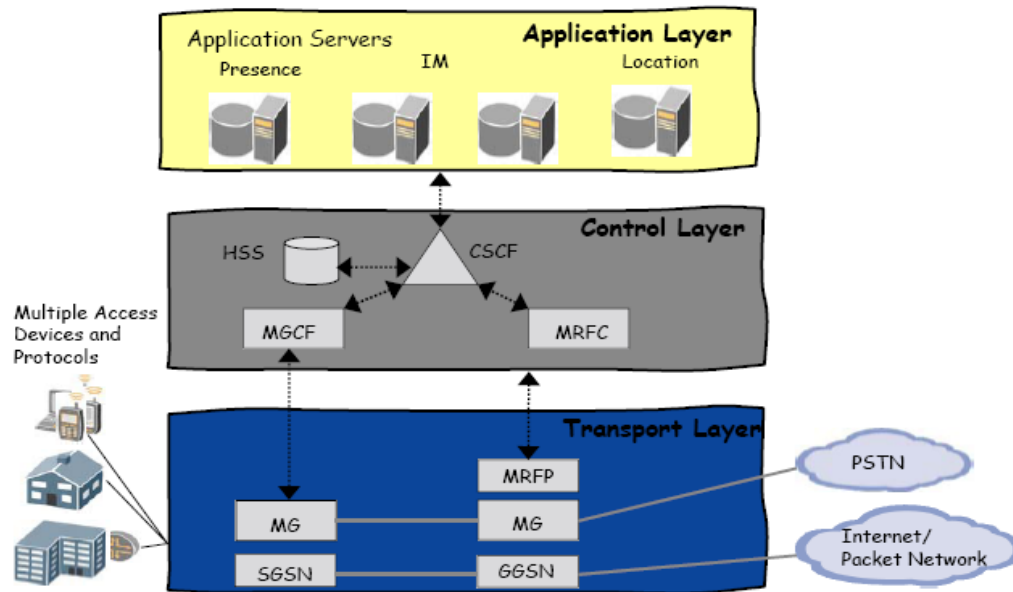
The main signalling protocol in IMS is the Session Initiation Protocol (SIP). SIP is the proposed standard today for multimedia communication between users interacting with voice, video and instant messaging. In IMS, the use of SIP facilitates interconnectivity between fixed and mobile networks. The requirements for managing a SIP session can be very complex, and it can be considered more complex than managing packets or even data flows.

5.3.2 The IMS Layered Model

The IMS architecture follows a layered model composed by three layers: the Application Layer, the Control Layer and the Transport Layer. This is in fact a departure from traditional telecommunications networks, where signalling, transport and applications are frequently integrated into single switches. This layered approach is aligned with other modern Next Generation Networks (NGN) architectures.

A high level view of the IMS architecture is shown in the Figure 37.

Figure 37: High level view of IMS architecture



Source: Sardella, 2006

More details on the functions of these layers and the devices commonly found in them are given in the following sections.

Transport Layer

The Transport Layer provides the core network architecture of the General Packet Radio Service (GPRS), which consists of support nodes for data services:

- A Serving GPRS Support Node (SGSN) for data services to mobile stations;
- A Gateway GPRS Support Node (GGSN) for gateways to the Internet or other data networks such as corporate WANs.

The Multimedia Resource Function Processor (MRFP) provides relevant multimedia resources (conferencing, announcements, interactive voice response, etc.). There is also an interface to connect the provider network to its internal Accounting and Billing Systems. The media gateways provide conversion between packet and circuit switched networks.

In general, this layer is where routers and switches, security firewalls and optical transport reside, along with gateways translating between protocols and between packets and circuit based traffic. Security is particularly important in the Transport Layer, and Denial of Service

(DoS) attacks must be parried through standard router hardening practices such as line rate packet filtering, rate limiting, flow replication and monitoring, and unicast reverse path forwarding (uRPF). To ensure session uptime, stateful firewall support on both native appliances and routers is also critical.

The nature of routing and switching is sophisticated with IMS, because the services and policies that enable transport require specific adaptations within the network infrastructure. Thus, the routing that occurs within the IMS transport layer is dependent on service quality variables such as Quality of Service (QoS), high availability (HA), and congestion and session management. The policies that set these features, often on a per-session basis, are set in a higher layer (the Control Layer) and enforced in the Transport Layer.

The need for ubiquitous access is illustrated on the Transport Layer. To take full advantage of the value of IMS services, devices will access the network over many technologies such as 3G, Wi-Fi, WiMax, DSL, fixed IP access, PSTN, etc.

Control Layer

The Control Layer provides session control and management, and is responsible for setting up and taking down packet sessions. It also contains the information on subscriber authentication, service authorization and location. This layer is essentially the “brains” of IMS, making the generic policy decisions that are enforced in the Transport Layer.

The Control Layer includes the SIP servers that register user devices and route signalling messages between them to set up sessions (that is referred to as the Call Session Control Function (CSCF)). The CSCF interacts with the Home Subscriber Server (HSS), which is the database containing subscriber profiles and preferences.

The border gateways on the Control Layer allow different networks to interoperate with each other. The Media Gateway Control Function (MGCF) and Multimedia Resource Function Controller (MRCF) interact with the CSCF and control the media gateways and media resources.

Application Layer

The Application Layer hosts application and content services. This layer includes data centers of application servers, web servers, etc. Also included here are generic service enablers that manage service elements like user groups and presence. These service elements connect to users through the control plane. Most of the new multimedia applications or application enablers, such as presence and location are supported by the Application Layer.

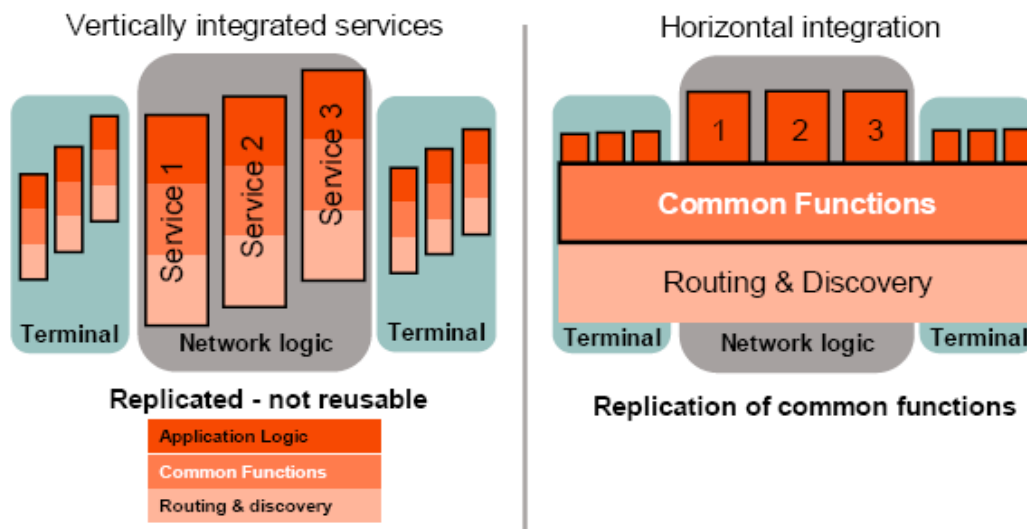
5.3.3 Service Creation and Delivery

In the pre-IMS world, services are specific and supported by a single logical node or set of nodes, performing specialized features for the service. Each service appears as an island, with its own service-specific node(s). The only possible way to interface between services, for example, for service composition is through protocols. In the absence of any common service framework, each service may have to be designed and implemented from scratch.

IMS takes the concept of layered architecture one step further by defining a horizontal architecture where service enablers and common functions can be reused for multiple applications. The horizontal architecture in IMS also specifies interoperability and roaming, and provides bearer control, charging and security.

The horizontal architecture of IMS enables operators to move away from traditional vertical 'stovepipe' implementations of new services, as shown in Figure 38.

Figure 38: Move of vertical integrated services to an horizontal integration



Source: Ericsson, 2004

This traditional network structure, with its service-unique functionality for charging, presence, group and list management, routing and provisioning, is very costly and complex to build and maintain. Separate implementations of each layer must be built for every service in a pre-IMS network, and the structure is replicated across the network, from the terminal via the core network to the other user's terminal.

IMS provides for a number of common functions that are generic in their structure and implementation, and can be reused by virtually all services in the network. IMS services are hosted by application servers, which mean they are implicitly placed in the IMS application layer, and that various aspects of service control are defined. Examples of these common functions are group/list management, presence, provisioning, operation and management, directory, charging and deployment.

In addition to speeding up and simplifying the service creation and delivery process, the reuse of common infrastructure, enablers and competence provided by IMS minimizes OPEX and CAPEX for operators, especially in areas such as service provisioning, O&M, customer care and billing.

Another advantage is that the operations competence required across services is more generic and can be overlaid with service-specific knowledge, rather than demanding specialist operational competence for each service.

IMS facilitates the creation and delivery of multimedia services based on common enablers in a 'write once, use many' way. These key elements in the IMS architecture are so-called service enablers. They represent generic and reusable building blocks for service creation. The service enablers developed for successful applications can become 'global enablers' that are automatically included in new applications and services.

There may be a large number of service enablers, but possibly the two most important are presence and group list management. In fact, IMS greatly simplifies the sign-on and authentication process, for both operators and users.

The presence service enabler allows a set of users to be informed about the availability and means of communication of the other users in the group. It enables a paradigm shift in person-to-person and other communications, for example, by enabling users to 'see' each other before connecting (active address book) or to receive alerts when other users become available.

In IMS, presence is sensitive to different media types, users (requestors), and user preferences. IMS presence function is also aware of what terminals the user can be reached on across the various wireline and wireless networks. Different rules can be set by the user to define who can view what information.

The group list management service enabler allows users to create and manage network-based group definitions for use by any service deployed in the network. There are generic mechanisms for notification of changes in group definitions. Application examples for group management include:

- Personal buddy list;
- 'Block' lists;
- Public/private groups (for example, the easy definition of VPN-oriented service packages);
- Access control lists;
- Public or private chat groups;
- Any application where a list of public identities is required.

In the pre-IMS world, each service often has its own way of authenticating users, which may be standardized or proprietary. It may not authenticate the user at all, relying instead on lower-level authentication. The operator may need to introduce a special Single Sign On (SSO) service in order to avoid re-authentication for multiple services.

Once authenticated through an IMS service, the user is able to access all the other IMS services that he is authorized to use. Authentication is handled by the CSCF as the user signs on. When it receives a service request, the SIP Application Server (AS) can verify that the user has been authenticated.

One of the key interfaces towards the end-user is the contact list. This not only lists the user's contacts, it also shows their availability and for which service on what terminal. When an end-

user logs on to his mobile phone or PC software client, the system is automatically updated on the user's new presence state.

IMS enables the reuse of inter-operator relations. Rather than develop different interconnect relations and agreements for each service, IMS enables a single inter-operator relationship to be established and built upon for each service.

The IMS enables the emergence of new services, like:

- Advanced Mobile Videophone – two-way, real-time, conversational video, with possibilities for person-to-multiparty transmissions and the ability to set up or receive other media calls;
- Multimedia Group Broadcast – voice call enhanced with multimedia elements, which can be either two-way or one-way. IMS Multimedia Group Broadcast would allow users with mobile devices to participate more fully in a web conference or webcast;
- Mobile Gaming – multi-player games service will seamlessly integrate sophisticated application (e.g., gaming) servers and clients. Presence and location information could also be integrated;
- Mobile VPN – IMS allows easier integration with other corporate networks and information resources that are all based on an IP architecture;
- Multimedia Messaging with Presence – send and receive multimedia attachments (video & audio clips, photos, etc) while allowing users to collaborate and interact with other users while creating and/or viewing the multimedia message.

Besides that, there are other interesting services like remote diagnostics dispatch (PTT) and personalized alerts with presence (Bienaimé, 2004).

5.3.4 An Enabler for Convergence

IMS can be seen as an enabler of true convergence and interworking in several dimensions: across fixed and mobile access, in the control and service layer and in the connectivity layer.

IMS started as a standard for wireless networks. However, the wireline community, in the search for a unifying standard soon realized the potential of IMS for fixed communication as well. A standard that was originally designed for mobile operators and adapted for wireline requirements is an excellent vehicle for fixed–mobile convergence.

Introduction of IMS can in some aspects be regarded as starting over with a clean slate. The application and control layers are ready to handle both fixed and mobile communication from the start.

Common functions and service enablers are equally equipped to work in both the fixed and mobile worlds and, more importantly, bridge the gap between them. Whether the subscriber is using a mobile phone or a PC client to communicate, the same presence and group list functions in IMS will be used. Additions or changes to a buddy list will directly be reflected on any terminal that the user logs on to. Different services have different requirements. Some

services demand high bandwidths, some demand low latency, others demand high processing power in the device. This means that in order for different services to be executed properly, the network has to be aware of the different characteristics of the access methods.

Multi-access functionality is inherent in the IMS architecture. If this is extended with access-aware control and service logic for multimedia services, IMS offers a way for fixed and mobile operators finally to deliver true fixed–mobile convergence. This will enable the delivered service to be adapted to the characteristics and capabilities of the currently selected device and its network access method.

With the introduction of portable devices like laptops and PDAs, used in conjunction with wireless LANs, the boundary between fixed and mobile communications has become blurred. One traditional distinction between fixed and mobile calls is that with a mobile call, one calls a person; whereas one calls a location using the wireline network. With personal SIP addresses, fixed calls can become personal as well, according to user needs. In this converged world, the device type will become more important than the underlying network architecture.

IMS services are primarily intended to address a mass market, with telecom-grade quality of service. In addition, to cater for millions of users IMS also needs to provide support for a complex service mix, that is, different service bundles that meet specific customer needs. These service bundles will most likely have different numbers of users, with different user behaviour, which will affect dimensioning of the network.

In this situation, the IMS network architecture offers a big advantage, since it is designed to scale independently of the traffic mix. This means that CSCF capacity can grow in proportion to the number of subscribers, and that the number of application servers can grow in proportion to utilization of the different services. In addition, the amount of inter-domain (for example, VoIP to PSTN) inter-working capacity can grow as services that utilize these capabilities are introduced.

5.4 VoIP

5.4.1 Introduction to VoIP

Voice over IP (VoIP) is a term used in IP telephony for a set of facilities that use the Internet Protocol (IP) to deliver voice information. In general, this means sending voice information in digital form in discrete packets rather than in the traditional circuit-committed protocols of the public switched telephone network (PSTN).

In carrier networks VoIP has been mainly deployed in enterprise networks or as a trunking technology to reduce transport costs in voice backbone networks. However, with many network operators facing eventual equipment obsolescence in their existing narrowband PSTN networks and with the drive to increase revenue by offering new and innovative multimedia services, it is expected that end-to-end VoIP solutions will be required to replace the PSTN in the medium term. Thus, in terms of market, VoIP can be seen as an emergent technology.

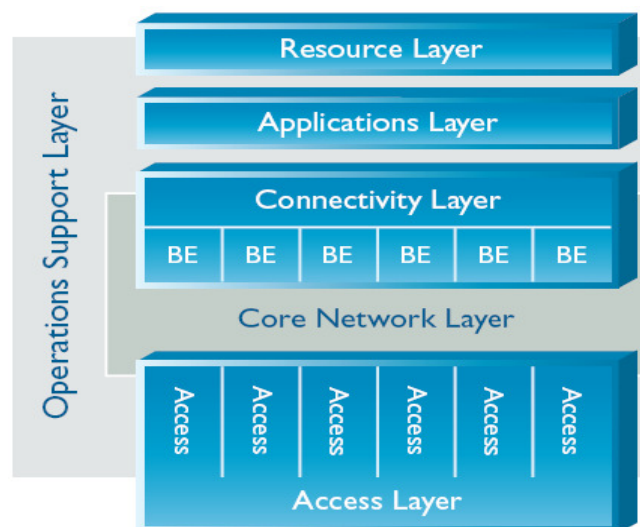
In order to deploy a VoIP network that is capable of providing a PSTN scale solution, the following issues must be addressed.

- What services need to be offered, for example full PSTN equivalence, a more restricted “cheap second line” service, or a simple user-to-user voice service;
- The types of end user terminals supported – POTS phones, PC clients, IP Phones or PBXs;
- Quality of Service requirement for voice to ensure that the agreed quality is provided;
- The security risks must be clearly identified and appropriate techniques employed to ensure that the call agents, in particular, are protected from attack;
- How much bandwidth is available in the last mile network, which will affect the choice of voice codec, packetization period, and where to use compression to best meet the service goals;
- The signalling protocol used must support the service set required;
- Lawful interception requirements in many countries could prevent a public carrier from allowing direct connection between IP phones. All calls may need to be routed via an access gateway that hides any intercepts in place.

5.4.2 VoIP Layers

The VoIP architecture can be devised in a series of layers, as proposed by AT&T and illustrated in Figure 39. The layers follow the principle of information hiding; that is, each layer has a well-defined role and provides a set of well-defined capabilities to the layer to which it is sending information, by using the capabilities of the layer it received information from.

Figure 39: VoIP layers



Source: AT&T, 2003

Access Layer

The Access Layer provides connectivity between the Customer Premises Equipment (CPE) and the various Border Elements (BEs). The Access Layer must support the end-users' service requirements such as Quality of Service (QoS), security, and availability.

The VoIP architecture is designed to provide customers with menus of services that are independent of access technologies. In the past, new access technologies were managed differently. With this architecture, new access technologies will be deployed quickly and efficiently without disturbing the existing VoIP infrastructure.

Core Network Layer

The primary function of the Core Network Layer, also known as the IP/MPLS Converged Network, is to provide high performance intersite routing and transport of IP packets. The Core Network Layer is a single network that provides IP connectivity for the VoIP infrastructure. The Core Network also has the added value of architecturally isolating the BEs and the associated Access Networks they connect with, from the Call Control Element (CCE), and associated service intelligence. The design facilitates inter-working among end-points in different access domains. That is, a multi-location customer could have a single voice-oriented service that works in the same way at all of the customer's locations regardless of how network connection is achieved (e.g., TDM, IP, ATM, Frame Relay, or remotely via a service partner like a cable company.)

Connectivity Layer

The VoIP Connectivity Layer provides all network primitives needed for applications to implement services. This includes establishing simple connectivity between end-points by providing capabilities to create, join, remove (tear down) and report the status of call legs. The following services are also enabled in this layer: Basic media services, E-911, CALEA and Call Detail Recording.

The Connectivity Layer provides a unified, shared environment that supports the addition of new services and access technologies without changing the basic infrastructure. This layer is comprised of a number of zones and a collection of network functions. A zone consists of a CCE managing one or more BEs. Network functions and resources, as described in this section, are shared by CCEs across many zones.

Applications Layer and Resource Layer

Application Servers (ASs) implement features that leverage the VoIP architecture, using a common interface to the VoIP Connectivity Layer. The "plug-in" paradigm facilitates fast and easy addition of new features, and SIP creates a unified interface to the Connectivity Layer. The Resource Layer contains all systems that various ASs may use to provide their services.

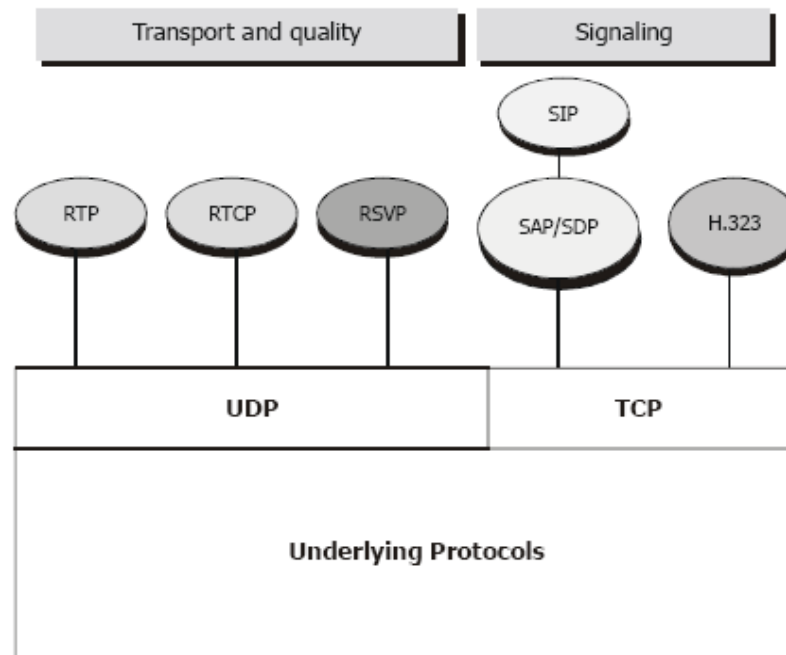
Operations Support Layer

The Operations Support Layer consists of multiple applications, databases, and a supporting data communications network used by internal and external personnel to manage the VoIP network and its elements.

5.4.3 VoIP Related Protocols

The figure 40 depicts the most important VoIP related protocols.

Figure 40: VoIP related protocols



Source: Mitra, 2001

H.323

The H.323 standard has been developed by the ITU-T, providing technical recommendations for voice communication over LANs, assuming that no Quality of Service (QoS) is being provided by LANs. It was originally developed for multimedia conferencing on LANs in 1996, but was later in 1998, extended to Voice over IP.

The H.323 standard proposes an architecture that is composed of four logical components:

- Terminals – there are LAN client endpoints that provide real-time, two-way communications. All H.323 terminals are required to support H.245, H.225, Q.931, Registration Admission Status (RAS) and real-time transport (RTP) protocols;
- Gateways – an H.323 gateway is an endpoint on the network that provides for real-time, two-way communications between H.323 terminals on the IP network with other ITU terminals on a switch-based network like PSTN or to another H.323 gateway;
- Gatekeepers – this is an important component of the H.323 architecture and functions as its “manager”. It is the central point for all calls within its zone and provides services

to the registered endpoints. A zone is the aggregation of the gatekeeper and the registered endpoints. A gatekeeper performs functions such as address translation, admissions control, call signalling, call authorization, call management and bandwidth management.

- Multipoint Control Units (MCU) – the MCU acts as an endpoint on the network for providing capability for three or more terminals and gateways to participate in a multipoint conference. The MCU consists of a mandatory Multipoint Controller (MC) and an optional Multipoint Processor (MP). The MC's functions are to determine the common capabilities of conferencing terminals, using the H.245 protocol. It however does not perform multiplexing of audio, video and data streams. The multiplexing of these media streams is handled by the MP under control of the MC.

Session Initiation Protocol

Session Initiation Protocol (SIP) is the IETF standard for voice or multimedia session establishment over the Internet. It was proposed as a standard (RFC 2543) in Feb. 1999. Its original author was Henning Schulzrinne. SIP is an application level protocol used for call setup management and teardown. SIP is used in association with its other IETF sister protocols like the SAP, SDP and MGCP (MEGACO) to provide a broader range of VoIP services. The SIP architecture is similar to HTTP (client-server protocol) architecture. It comprises requests that are sent from the SIP user client to the SIP Server. The Server processes the request and responds to the client. A request message, together with the associated response messages makes a SIP transaction.

SIP makes minimal assumptions about the underlying transport protocol and itself provides reliability and does not depend on the underlying protocol's characteristics. SIP depends on Session Description Protocol (SDP) for negotiation of session parameters such as codec identification and media. It supports user mobility through proxy servers and redirecting requests to the user's currently registered location.

Some major SIP features are as follows:

- Call setup – session establishment with agreed call parameters between the two endpoints;
- Renegotiate call parameters – renegotiate session parameters while the call is in progress;
- User location – determination of the end system location to be used for communication, given the user's email style address;
- User availability – determination of the willingness of the called party to engage in a conversation;
- User capabilities – determination and negotiation of the media and call parameters to be used in the session;
- Call handling – transfer and termination of the call.

One of the major concerns of a VoIP solution is around the interoperability problem using SIP. Establishing a truly standards-based dominant solution in the market requires a broadly accepted technology and a business model that leads to pervasive adoption. One of the best ways to achieve that is combining the two parallel worlds: VoIP and Open Source. In fact, we can find in the market several Open Source implementations of the SIP protocol.

A more detailed vision about the SIP architecture and applications can be found in Annex G.

Session Description Protocol (SDP) and Session Announcement Protocol (SAP)

SDP is an IETF specified protocol (RFC2327) that helps in describing multimedia sessions. It is used for session announcements, session invitation, etc. For example, the SDP payload gets included in the SIP INVITE packet to convey information about the sender to the recipient and vice versa, before participating in the session. This allows media information to be similarly shared between the parties. An SDP payload includes the following information:

- Session name and purpose;
- Address and port number;
- Start and stop times;
- Media information;
- Bandwidth requirement;
- Contact information.

The SAP protocol is used for advertising multicast conferences and multicast sessions. A SAP announcer periodically multicasts announcement packets to a well known multicast address and port (port number: 9875). The SAP listener listens to the well known SAP address and port and learns of the multicast scopes using the Multicast Scope Zone Announcement Protocol. A SAP announcer is unaware of the presence or absence of SAP listeners. A SAP announcement is multicast with the same scope as the session it is announcing, thus ensuring that the recipients of the announcement can also be potential recipients of the session being advertised. If a session uses addresses in multiple administrative scope ranges, it is necessary for the announcer to send identical copies of the announcement to each administrative scope range. It is alright for multiple announcers to announce a single session, thus ensuring robustness of the protocol.

The intervening time period between announcements is decided such that the total bandwidth used by all the announcements in a single SAP group is less than a pre-configured limit. Each announcer is required to listen to all the announcements in its group in order to determine the total number of sessions being announced in the group. One of the protocol's objectives is to announce the existence of long-lived wide area multicast sessions and involves a large startup delay before a complete set of announcements is heard by a listener.

SAP Proxy caches can also be deployed to reduce the inherent delays in SAP. A SAP proxy is expected to listen to all SAP groups in its scope and maintain an up to date list of all announced sessions along with the last receipt time of each announcement.

SAP also contains mechanisms to ensure the integrity of session announcements, announcement encryption and also to authenticate the origin of an announcement.

Real-time Transport Protocol (RTP)

RTP is used to transfer real-time media, such as audio and video, over packet switched networks. It is used by both SIP and H.323 protocols. The protocol provides timing information to the receiver so that it can correctly compensate for delay jitter. It also allows the receiver to detect packet loss and take appropriate measures. The RTP header contains information that assists the receiver to reconstruct the media and also the information about how the CODEC bitstreams are fragmented into packets. RTP is specified by IETF in RFC1889 and provides functions such as sequencing, payload and source identification, frame indication and intra-media synchronization. Intra-media synchronization is normally implemented as a play-out buffer to compensate for delay jitter.

Real-time Transport Control Protocol (RTCP)

RTCP is a control protocol that works in conjunction with RTP. In an RTP session, the endpoints periodically send RTCP packets to disseminate useful information about parameters such as the QoS. The endpoints can then take appropriate measures to efficiently transport the media over the RTP session.

Some of the functions that RTCP provides are QoS Feedback, Session control, User Identification and Inter media synchronization, to synchronize between the audio and video streams. For example, to synchronize the lip movement (in video) with the speech (in audio) streams (Mitra, 2001)

Other Protocols

Other relevant protocols that can be used in a VoIP communication are Media Gateway Control Protocol (MGCP) and Real-time Streaming Protocol (RTSP).

MGCP defines the communication between “Call Agents” (call control elements) and gateways. Call Agents are also called Media Gateway Controllers. It is a control protocol that monitors the events on IP phones and gateways and instructs them to send media to specified addresses. MGCP has evolved from two earlier protocols: the Simple Gateway Control Protocol and the Internet Protocol Device Control. As per recommendations, the call control intelligence is located outside the gateway in the Call Agents. These Call agents are assumed to have synchronized with each other and they issue coherent commands to the gateways under their control. The issued commands are executed by the gateways in a master/slave manner. MGCP defines the concepts of “Endpoints” and “Connections” to describe and establish voice paths between two participants. Similarly, it has defined “Events” and “Signals” to describe set-up or teardown of sessions. MGCP is intended to be a simple protocol for enabling development of reliable and cheap local access systems.

RTSP is a client/server protocol that provides control over the delivery of real-time media streams. It is akin to a “VCR-style” remote control for audio and video streams. Functions such as pause, fast forward, reverse and absolute positioning are provided to the user. It also allows the user to choose the RTP-based delivery mechanisms and also a delivery channel

such as UDP, multicast UDP and TCP over IP. The RTSP functions between the media servers and its clients and establishes and controls the connecting audio and video media streams. The media server provides playback and recording of the media streams to the client, whereas the client can request such services from the media server.

RTSP is an application level protocol similar to HTTP but is meant for audio and video. It requires maintenance of states and allows bi-directional requests between client and server. Further, RTSP requests are used by the client to retrieve media, or invite a server to a conference or add a new media to an existing presentation at the server.

5.4.5 Quality of Service

The main goal of Quality of Service (QoS) is to help reduce or eliminate delay of voice packets including packet loss that travels across a network. It can be defined as the capability of a network to provide better service to selected network traffic over various underlying technologies such as Frame Relay, ATM and IP. This network feature helps in differentiating different classes of traffic and treats them differently. The various formal measurements of QoS are:

- Service availability – the availability of the user's network connection and depends on the connected network device;
- Throughput – the packet delivery rate at the endpoints;
- Delay – the end-to-end packet delay, while traversing the network;
- Delay jitter – the delay variation among similar packets traversing the same path in the network;
- Packet loss rate – the rate of packet loss, because of packet dropping and corruption.

QoS of networks should attempt to maximize service availability and throughput, while at the same time minimizing the remaining measurements.

In the current network scenario, different types of traffic (such as real-time and data) need to share the same network link. These different kinds of traffic require different treatment from the network. This is similar to a first class passenger of an airplane demanding preferential treatment over other passengers. Apart from providing special treatment, a separate airplane can't be made available to the first class passenger, similarly a separate link or a network connection can't be given to different customers, though the treatment given can be different. The entire bandwidth has to be shared between priority traffic and regular traffic, and only at places where the traffic flows through active network elements like routers, can these flows be differentiated and treated differently.

The different types of traffic can be grouped as:

- Non Real-time or Data – these applications only care about reliable packet delivery like that guaranteed in TCP. They are immune to delays or bandwidth requirements. Examples are web browsing, email, distributed computing, etc;

- Real-time – these applications require timely delivery along with reliability. Some of these applications can tolerate an upper bound in delay, whereas others are totally intolerant. This range of expectations is used to further classify real-time applications by QoS models.

There are three major architectures or service models for implementing QoS in packet networks. These are:

- Best Effort Service – In this model there are no QoS guarantees given to the application, except that a best effort to deliver will be made;
- Integrated Service – It is also called IntServ. This is an earlier model (1995) devised for integrated service networks such as ISDN or ATM. It believed to have end-to-end QoS strategies implemented at the network elements for all classes of traffic flows;
- Differentiated Service – also called DiffServ. This model was developed later (around 1998), wherein unlike the IntServ, it implements QoS strategies on per hop basis as Per Hop Behavior (PHB), and avoids signalling mechanisms. It tries to differentiate individual packets and responds with a different behaviour according to their class.

5.5 Mobile Ad Hoc Networks

5.5.1 The Notion of the Mobile Ad Hoc Networks

A Mobile Ad Hoc Network (MANET) is a network architecture that can be rapidly deployed without relying on pre-existing fixed network infrastructure. The nodes in a MANET can dynamically join and leave the network, frequently, often without warning, and possibly without disruption to other nodes' communication. Finally, the nodes in the network can be highly mobile, thus rapidly changing the node constellation and the presence or absence of links.

Examples of the use of the MANETs are:

- Tactical operation – for fast establishment of military communication during the deployment of forces in unknown and hostile terrain;
- Rescue missions – for communication in areas without adequate wireless coverage;
- National security – for communication in times of national crisis, where the existing communication infrastructure is non-operational due to a natural disaster or a global war;
- Law enforcement – for fast establishment of communication infrastructure during law enforcement operations;
- Commercial use – for setting up communication in exhibitions, conferences or sales presentations;
- Educational – for operation of wall-free (virtual) classrooms;

- Sensor networks – for communication between intelligent sensors (e.g., Micro-Electro-Mechanical-Systems) mounted on mobile platforms.

Nodes in the MANET exhibit nomadic behaviour by freely migrating within some area, dynamically creating and tearing down associations with other nodes. Groups of nodes that have a common goal can create formations (clusters) and migrate together, similarly to military units on missions or to guided tours on excursions. Nodes can communicate with each other at any time and without restrictions, except for connectivity limitations and subject to security provisions. Examples of network nodes are pedestrians, soldiers, or unmanned robots. Examples of mobile platforms on which the network nodes might reside are cars, trucks, buses, tanks, trains, planes, helicopters or ships.

MANETs are intended to provide a data network that is immediately deployable in arbitrary communication environments and is responsive to changes in network topology. Because ad hoc networks are intended to be deployable anywhere, existing infrastructure may not be present. The mobile nodes are thus likely to be the sole elements of the network. Differing mobility patterns and radio propagation conditions that vary with time and position can result in intermittent and sporadic connectivity between adjacent nodes. The result is a time-varying network topology.

MANETs are distinguished from other ad-hoc networks by rapidly changing network topologies, influenced by the network size and node mobility. Such networks typically have a large span and contain hundreds to thousands of nodes. The MANET nodes exist on top of diverse platforms that exhibit quite different mobility patterns. Within a MANET, there can be significant variations in nodal speed (from stationary nodes to high-speed aircraft), direction of movement, acceleration/deceleration or restrictions on paths (e.g., a car must drive on a road, but a tank does not). A pedestrian is restricted by built objects while airborne platforms can exist anywhere in some range of altitudes. In spite of such volatility, the MANET is expected to deliver diverse traffic types, ranging from pure voice to integrated voice and image, and even possibly some limited video.

5.5.2 The Communication Environment

A MANET is a *peer-to-peer* network that allows direct communication between any two nodes, when adequate radio propagation conditions exist between these two nodes and subject to transmission power limitations of the nodes. If there is no direct link between the source and the destination nodes, *multi-hop* routing is used. In multi-hop routing, a packet is forwarded from one node to another, until it reaches the destination. Of course, appropriate routing protocols are necessary to discover routes between the source and the destination, or even to determine the presence or absence of a path to the destination node. Because of the lack of central elements, distributed protocols have to be used.

The main challenges in the design and operation of the MANETs, compared to more traditional wireless networks, stem from the lack of a centralized entity, the potential for rapid node movement, and the fact that all communication is carried over the wireless medium. In

standard cellular wireless networks, there are a number of centralized entities (e.g., the basestations, the Mobile Switching Centers (MSCs), the Home Location Register (HLR), and the Visitor Location Register (VLR)). In ad-hoc networks, there is no pre-existing infrastructure, and these centralized entities do not exist. The centralized entities in the cellular networks perform the function of coordination. The lack of these entities in the MANETs requires distributed algorithms to perform these functions. In particular, the traditional algorithms for mobility management, which rely on a centralized HLR/VLR, and the medium access control schemes, which rely on the base-station/MSC support, become inappropriate.

All communications between network entities in ad-hoc networks are carried over the wireless medium. Due to the radio communications being vulnerable to propagation impairments, connectivity between network nodes is not guaranteed. In fact, intermittent and sporadic connectivity may be quite common. Additionally, as the wireless bandwidth is limited, its use should be minimized. Finally, as some of the mobile devices are expected to be handheld with limited power sources, the required transmission power should be minimized as well. Therefore, the transmission radius of each mobile is limited, and channels assigned to mobiles are typically spatially reused. Consequently, since the transmission radius is much smaller than the network span, communication between two nodes often needs to be relayed through intermediate nodes; i.e., multi-hop routing is used.

Because of the possibly rapid movement of the nodes and variable propagation conditions, network information, such as a route table, becomes obsolete quickly. Frequent network reconfiguration may trigger frequent exchanges of control information to reflect the current state of the network. However, the short lifetime of this information means that a large portion of this information may never be used. Thus, the bandwidth used for distribution of the routing update information is wasted. In spite of these attributes, the design of the MANETs still needs to allow for a high degree of reliability, survivability, availability, and manageability of the network.

Based on the above discussion, the following features are required for the MANETs:

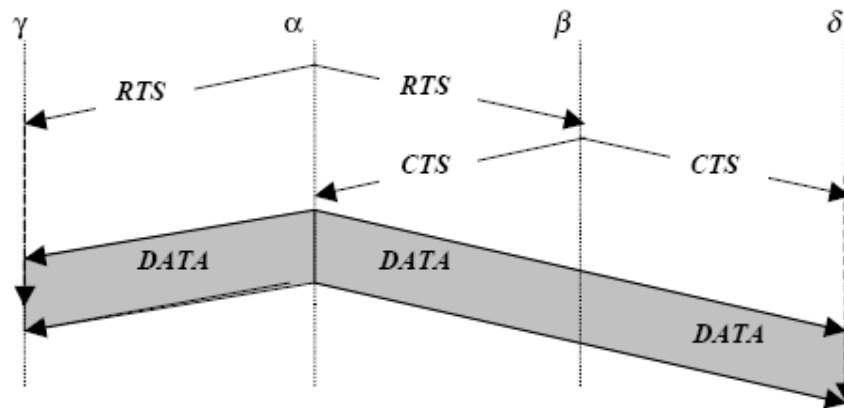
- Robust routing and mobility management algorithms to increase the network's reliability and availability; e.g., to reduce the chances that any network component is isolated from the rest of the network;
- Adaptive algorithms and protocols to adjust to frequently changing radio propagation, network and traffic controls;
- Low-overhead algorithms and protocols to preserve the radio communication resource;
- Multiple (distinct) routes between a source and a destination, to reduce congestion in the vicinity of certain nodes, and to increase reliability and survivability;
- Robust network architecture to avoid susceptibility to network failures, congestion around high-level nodes and the penalty due to inefficient routing.

5.5.3 MAC-Layer Protocols for Ad Hoc Networks

Applicability of the existing MAC-layer protocol, in particular the family of the *Carrier Sense Multiple Access (CSMA)*, to the radio environment is limited by the following two interference mechanisms: the *hidden terminal* and the *exposed terminal* problems. In general, the *hidden terminal* problem reduces the capacity of a network due to increasing the number of collisions, while the *exposed terminal* problem reduces the network capacity due to the unnecessarily deferring nodes from transmitting.

Several attempts have been made in the literature to reduce the ill effect of these two problems. The necessity of a dialogue between the transmitting and the receiving nodes that preempts the actual transmission, and that is referred to as the *RTS/CTS dialogue*, has been generally accepted.

Figure 41: Example of a RTS/CTS dialogue



Source: Haas and Deng, 2006

The RTS/CTS dialogue is depicted in Figure 41. A node ready to transmit a packet, send a short control packet, the *Request To Send (RTS)*, with all nodes that hear the RTS defer from accessing the channel for the duration of the RTS/CTS dialogue. The destination, upon reception of the RTS responds with another short control packet, the *Clear To Send (CTS)*. All nodes that hear the CTS packet defer from accessing the channel for the duration of the DATA packet transmission. The reception of the CTS packet at the transmitting node acknowledges that the RTS/CTS dialogue has been successful and the node starts the transmission of the actual data packet. Although the RTS/CTS dialogue does not eliminate the *hidden* and the *expose terminal* problems, it does provide some degree of improvement over the traditional CSMA schemes.

Following, we present a number of attempts to further improve the performance of the MAC-layer protocols for ad hoc networks:

- **The Multiple Access Collision Avoidance (MACA) scheme** - Karn proposed the use of RTS/CTS dialogue for collision avoidance on the shared channel. Through the use of the RTS/CTS dialogue, the MACA scheme reduces the probability of data packet collisions caused by hidden terminals. The RTS packet in the MACA scheme has a similar function as that of the packet preamble in the *RI-BTMA* scheme. The *RI-*

BTMA scheme does not have the CTS packet because it uses a busy tone to notify the communication initiator. Since the CTS packet may suffer from packet collisions, the notification from CTS packets is not as safe as that from the busy tone in the RI-BTMA scheme. An example is the reception failure of CTS packet at some hidden nodes because of transmissions from other nodes;

- **The MACAW scheme** - Bharghavan suggested the use of the RTS-CTS-DS-DATA-ACK message exchange for a data packet transmission in the MACAW protocol (Haas, 2006). Two new control packets were added to the packet train: DS and ACK packets. When the transmitter receives the CTS packet from its intended destination, it sends out a DS (Data Sending) packet before it transmits the data packet. The DS packet notifies neighbour nodes of the fact that a RTS/CTS dialogue has been successful and a data packet will be sent. The ACK packet was implemented for immediate acknowledgment and the possibility of fast retransmission of collided data packets instead of upper-layer retransmission;
- **The Dual Busy Tone Multiple Access (DBTMA) scheme** – Dean and Haas proposed, in addition to the use of an RTS packet, the use of two out-of-band busy tones to notify neighbour nodes of the channel status. When a node is ready to transmit, it sets up its Transmit Busy Tone and sends out an RTS packet to its intended receiver. On reception of the RTS packet, the receiver sets up a busy tone (the Receive Busy Tone) and waits for the incoming data packet. The Receive Busy Tone operates similarly to the busy tone of the RI-BTMA scheme. However, with the help of the second busy tone (the Transmit Busy Tone), the probability of RTS packets being collided is decreased and the performance is improved.

5.5.4 Routing Protocols for Ad Hoc Networks

Traditionally, the network routing protocols could be divided into *proactive protocols* and *reactive protocols*. Proactive protocols continuously learn the topology of the network by exchanging topological information among the network nodes. Thus, when there is a need for a route to a destination, such route information is available immediately. The early protocols that were proposed for routing in ad hoc networks were proactive Distance Vector protocols based on the *Distributed Bellman-Ford (DBF)* algorithm (Haas, 2006).

The main issue with the application of proactive protocols to the ad hoc networking environment stems from the fact, that the topology continuously changes, the cost of updating the topological information may be prohibitively high, moreover, if the network activity is low, the information about the actual topology may even not be used and the investment of limited transmission and computing resources in maintaining the topology is lost.

On the other “end of the spectrum” are the *reactive* routing protocols, which are based on some type of “query-reply” dialog. Reactive protocols do not attempt to continuously maintain the up-to-date topology of the network. Rather, when the need arises, a reactive

protocol invokes a procedure to find a route to the destination; such a procedure involves some sort of flooding the network with the route query. For this reason, these protocols are often also referred to as *on demand*. Examples of reactive protocols include the *Temporally Ordered Routing Algorithm (TORA)*, the *Dynamic Source Routing (DSR)*, and *Ad hoc On Demand Distance Vector (AODV)*.

So, both of the routing “extremes”, the proactive and the reactive schemes, may not perform best in a highly dynamic networking environment, such as in ad hoc networks. Although proactive protocols can produce the required route immediately, they may waste too much of the network resources in the attempt to always maintain the updated network topology. The reactive protocol, on the other hand, may reduce the amount of used network resources, but may encounter excessive delay in the flooding of the network with routing queries. Another approach to address the routing problem was through the *hybrid* protocols, which incorporate some aspects of the proactive and some aspects of the reactive protocols. The Zone Routing Protocol (ZRP) is an example of the hybrid approach. In ZRP, each node proactively maintains the topology of its close neighborhood only, thus reducing the amount of control traffic relative to the proactive approach. To discover routes outside its neighborhood, the node reactively invokes a generalized form of controlled flooding, which reduces the route discovery delay, as compared with purely reactive schemes. The size of the neighborhood is a single parameter that allows optimizing the behavior of the protocol based on the degree of nodal mobility and the degree of network activity (Haas, 2006).

Following, we present a number of examples of routing protocols that were developed for the ad hoc networking environment.

Single-scope routing protocols

The main advantage of the single-scope routing protocols, in comparison with the multi-scope routing protocols, is their lower complexity. There is no distinction of nearby or faraway nodes, and there is no need to maintain a hierarchical structure. Therefore, they are generally simpler to implement, both in simulations and in practical systems. The current activities within the IETF MANET group predominantly involve single-scope routing.

However, inefficient resource management can result from treating nodes equally, regardless of their relative location. For example, it may not be necessary for a node to maintain very accurate link-state tables or route caching information of faraway nodes. Therefore, the single-scope routing protocols may not scale well as the network size increases.

The single-scope routing protocols can be categorized into reactive (or on-demand) and proactive (or table-driven) ones. The main advantage of the reactive protocols is that no routing-table updating is required unless a route is used. Therefore, battery power and wireless bandwidth can be conservatively utilized. However, when a route is needed, the source node needs to query for the route. That can lead to routing delay. Furthermore, an efficient route querying mechanism is required in order to prevent overloading the network with query packets.

On the other hand, the proactive protocols generally provide a source node with readily available routes to all other nodes. They incur no routing delay or query traffic. The

disadvantage of the proactive protocols is that they may incur unnecessary control traffic in maintaining up-to-date topology information, whether that information is needed for routing or not.

Multi-Scope Routing Protocols

The multi-scope routing protocols distinguish nodes by their relative positions. More resource is devoted to maintaining the topology information of more nearby, and hence more frequently used, part of the network. Therefore, scalability is the main advantage of the multi-scope routing protocols.

The disadvantage is their relative complexity in comparison with the single-scope routing protocols. Ranking mechanisms that distinguish the nodes are required. Furthermore, they generally need to be reconfigurable, in order to adapt to the changing network topology and the varying node traffic and movement patterns.

Multi-scope routing can be categorized into the flat protocols and the hierarchical protocols. The main advantage of the flat protocols, in comparison with the hierarchical ones, is that they do not require specialized nodes. All nodes serve the same set of functions. Therefore, they are relatively simple to implement, and they avoid the control message overhead and non-uniform loading involved in node specialization. However, since the flat structure does not have special nodes that can provide locally centralized functionality, the nodes between nearby local scope exchange link information in a strictly distributive manner. Thus, the lack of coordination can lead to inefficiency.

On the other hand, the hierarchical protocols utilize specialized nodes, such as the cluster heads, group leaders, or the route gateways, to coordinate the dissemination of local link information. Furthermore, the relative position of the specialized nodes can provide directional guidance to routing between the regular nodes. However, the dynamic maintenance of the hierarchy can potentially take away a large amount of the battery power and wireless bandwidth from routing itself, especially when the network is highly mobile. Furthermore, mechanisms are needed to avoid overloading the local controllers and to alleviate the traffic hot spots.

5.5.5 Security of Ad Hoc Networks

The provision of security services in the MANET context faces a set of challenges specific to this new technology. The insecurity of the wireless links, energy constraints, relatively poor physical protection of nodes in a hostile environment, and the vulnerability of statically configured security schemes have been identified as main challenges. Nevertheless, the single most important feature that differentiates MANET is the absence of a fixed infrastructure. No part of the network is dedicated to support individually any specific network functionality, with routing (topology discovery, data forwarding) being the most prominent example. Additional examples of functions that cannot rely on a central service, and which are also of high relevance, are naming services, certification authorities (CAs), directory and other administrative services.

Even if such services were assumed, their availability would not be guaranteed, either due to the dynamically changing topology that could easily result in a partitioned network, or due to congested links close to the node acting as a server. Furthermore, performance issues, such as delay constraints on acquiring responses from the assumed infrastructure, would pose an additional challenge.

The absence of infrastructure and the consequent absence of authorization facilities impede the usual practice of establishing a line of defence, separating nodes into trusted and non-trusted. Such a distinction would have been based on a security policy, the possession of the necessary credentials and the ability for nodes to validate them. In the MANET context, there may be no ground for an *a priori* classification, since all nodes are required to cooperate in supporting the network operation, while no prior security association can be assumed for all the network nodes. Additionally, in MANET freely roaming nodes form transient associations with their neighbours; join and leave MANET sub-domains independently and without notice. Thus it may be difficult in most cases to have a clear picture of the ad hoc network membership. Consequently, especially in the case of a large-size network, no form of established trust relationships among the majority of nodes could be assumed.

In such an environment, there is no guarantee that a path between two nodes would be free of malicious nodes, which would not comply with the employed protocol and attempt to harm the network operation. The mechanisms currently incorporated in MANET routing protocols cannot cope with disruptions due to malicious behaviour. For example, any node could claim that is one hop away from the sought destination, causing all routes to the destination to pass through itself. Alternatively, a malicious node could corrupt any in-transit route request (reply) packet and cause data to be misrouted.

The presence of even a small number of adversarial nodes could result in repeatedly compromised routes, and, as a result, the network nodes would have to rely on cycles of timeout and new route discoveries to communicate. This would incur arbitrary delays before the establishment of a non-corrupted path, while successive broadcasts of route requests would impose excessive transmission overhead. In particular, intentionally falsified routing messages would result in a *denial-of-service (DoS)* experienced by the end nodes.

Despite the fact that security of MANET routing protocols is envisioned to be a major “roadblock” in commercial application of this technology, only a limited number of works has been published in this area. In the sequel, we review some schemes related to the problem of incorporating security provisions within the context of ad hoc communication.

In threshold cryptographic scheme proposed by Zhou and Haas, the authority of CA is distributed among many $t+1$ network nodes, called servers, to minimize the chance of a single CA being compromised. All the nodes' certificates are divided into n shares and distributed to server nodes before network formation. If a node requires other node's public key, it requests to server nodes which generate their partial signatures individually and send to combiner to form a signature and present to the asking node. In MANET it is a cumbersome process that may cost more than a MANET's formation objective (Zhou and Haas, 1999). A similar scheme proposed by Kong is an improvement over Zhous and Haas study on the basis of

availability. Here, the CA is a fully distributed and any $t+1$ number of nodes in MANET could behave as server nodes for issuance and verification of public keys for the nodes. Despite the advantage of availability, the scheme loses on the side of robustness with the higher values of t . The selection of t should be trade-off between both of the parameters (Kong, 2001).

In KAMAN approach proposed by Pirzada and Mc Donald, multiple Kerberos servers are responsible for distributed authentication in MANET. The servers are boot-strapped with keys shared with the client nodes. The users rely upon servers for acquiring tickets after authentication to communicate with other users which is a bottleneck for its implementation in MANETs and the servers are not trusted as there is no Trusted Third Party (TTP) involved initially (Pirzada and Mc Donald, 2004).

In self-organized MANETS approach presented by Capkun, the nodes rely on themselves for all routing, authentication and mobility management. The nodes issue certificates to their trustees for bringing them into MANET which are verified on the basis of repositories maintained by the nodes. Though, the scheme is self-organized but has the overheads of maintaining repositories which consumes the memory and bandwidth. Secondly, the originator blindly trusts any other node for making a new entry in the MANET (Capkun, 2003).

6 Case Studies

6.1 Short Overview

In this chapter we look to some case studies of companies that incorporate Open Source software or hardware in the area of telecommunications. In a first instance (section 6.2) we present the data analysis approach that is followed to perform this study. Consecutively (section 6.3) we introduce the methodology and the most important concepts associated with the proposed methodology used to describe the case studies. In this section we introduce the concepts of core competences, capabilities and business strategy. Later (section 6.4) we explain the criteria used to choose the companies presented as case studies. Finally (section 6.5) we analyze each case study of telecom companies that integrate Open Source solutions in their commercial products. We analyze the following seven companies: Netcall, VipVoz, Nextstag, Bicom Systems, Critical Links, iPortalMais and the project VoIP@FEUP developed at CICA division of FEUP.

6.2 Data Analysis Approach

Ideally, to evaluate the economic robustness of a business model, we would select a large statistically representative sample of telecom companies and compare their economic results and find out what is or are the best business models' approaches. However, this evaluation would only give information about the economic results and wouldn't take into account important attributes of the management, such as the human resources and leadership. These concepts can affect the final results of the company and can't be measured using a statistical approach.

The approach that we will follow is based in the analysis of some case studies of telecommunications companies that are already in the market. This analysis intends to study the positioning of these companies in the telecommunications value chain, its major core competences and adopted strategy. We will study companies that use Open Source software in their commercialization activities, namely employing the Asterisk and SIP platforms. We can find detailed information about the Asterisk and SIP platforms in annexes F and G, respectively.

We will conduct several in-depth interviews to relevant members of each company, when this alternative is possible attending to the location headquarters of each company and the availability of their staff. In the cases where the interview approach won't be possible to do, we will send by email a set of questions and topics identical to the one that we prepared for the interviews.

Interviews have the big advantage of capturing the perspectives of participants, staff, and others associated with the project. In the hypothetical example, interviews with project staff can provide pertinent information on the early stages of the implementation and problems encountered. The use of interviews as a data collection method begins with the assumption that the participants' perspectives are meaningful, knowable, and able to be made explicit, and

that their perspectives affect the success of the project. An interview, rather than a paper and pencil survey, is selected when interpersonal contact is important and when opportunities for follow up of interesting comments are desired (NSF, 2007).

The literature refers that two types of interviews can be used in evaluation research: structured interviews, in which a carefully worded questionnaire is administered, and in-depth interviews, in which the interviewer does not follow a rigid form (NSF, 2007).

An in-depth interview is a dialogue between a skilled interviewer and an interviewee. Its goal is to elicit rich, detailed material that can be used in analysis. In-depth interviews are characterized by extensive probing and open-ended questions. Typically, we will prepare an interview guide that includes a list of questions or issues that are to be explored and suggested probes for following up on key topics. However, the intention is not to break the dynamics of an interview, but only to help making the interviewing process more systematic and comprehensive.

We also intend to get information from public records as an input for our study. These public records will be collected from the outside and internal environment of each company. Examples of external records that will be used are statistics reports, newspapers archives and articles about the company available in magazines and Internet. On the other hand, examples of internal records include historical accounts, institutional mission statements, annual reports, minutes of meetings and presentations.

6.3 Case Studies Methodology

In our case studies we will follow the methodology proposed by Michael Porter to analyze the competitive advantage of a company with the contribution of other theories from several authors, like Hamel and Pisano, about the competences and dynamic capabilities theories.

In a first instance we will propose to establish the core competences of a company. These distinctive competencies can be based in three sources: internal resources, human based competences and dynamic capabilities. After this step we can define the strategy followed by the company, if it is a cost advantage or a differentiation advantage, in a global or niche market. The value creation of company to the market depends of the strategy defined by the company and perceived by the consumer market.

Core competencies are the crown jewels of a company and, therefore, should be carefully nurtured and developed. Companies can determine future business directions based on the strengths of competencies. However, because generalized terms such as resource, asset, capability, and competence are not clearly explained in connection with competence theory, there is difficulty in understanding many contemporary management concepts.

Traditional “competitive forces theory” asserts that in order to gain competitive advantage, a firm must exploit those forces driving the market dynamics. For example, Porter suggests that the market power of a firm may be increased by leveraging the market segment and industry structure. It is argued that firms are homogeneous in their stocks of assets and capabilities.

Therefore, the tactical manoeuvring of external market forces forms a major factor in attaining competitive advantage

A limitation of Porter's five forces model is that it is unable to address intellectual capital/property as a determinant of differentiation between business success and failure. In recent years, globalization trends and increased market competition have forced companies to look into other means to further increase their competitive edge. For example, concepts have emerged encouraging management to strategically exploit those resources and capabilities, which are unique in competition. The term "core competence" was used by Prahalad and Hamel to deal with capabilities within diversified firms and also several measures have been proposed on how to identify unique resources and capabilities (Hafeaz, 2002).

6.3.1 Resource-based View

With the resource-based view, a firm is understood to be a bundle of assets and capabilities. The competitive advantage is acquired by accumulating strategic assets and capabilities. This is opposed to the competitive forces approach where industry structure and/or market segments are the competitive factors. However, the resource-based view argues that firms are heterogeneous to one another because they possess some unique assets and/or capabilities. These unique assets and capabilities, often known as strategic resources, can make all the difference in creating a competitive advantage for a firm. Therefore, management efforts should be focused toward nurturing and exploiting these strategic resources.

6.3.2 Competence-based Perspective

Competence-based perspective argues that it is the core competencies of a firm (not discrete, individual assets), which are the source of sustainable competitive advantage. Core competencies are usually the result of "collective learning" processes, and are manifested in business activities and processes. The core competencies are those unique capabilities, which usually span over multiple products or markets. Compared to the resource-based view, this approach stresses the development of the right competencies for the long-term success of a firm.

6.3.3 Dynamic Capabilities Approach

The dynamic capabilities approach claims that the competitive advantage comes through leveraging the managerial and organizational processes of a firm, and is shaped by the strategic positioning of its assets and available paths. Also, long term competitiveness of the firm largely depends upon its "dynamic" capabilities. The term "dynamic" is defined as the capacity to renew competencies so as to achieve congruence with the changing business environment. The firm's ability to continuously generate new forms of competitive advantage is greatly influenced by its current competence endowment.

There are common elements in the three perspectives as indicated in Table 5. However, all these advocate that the competitive strategy is shaped by exploiting or redeploying these resources or competencies. This rather “inward” view is quite challenging to Porter’s five forces model where an “outward” context in terms of external markets or industry structure is taken as the main differentiation factor. The resource-based approach focuses upon controlling and exploiting resources. This differs from the stance taken by the other two perspectives, where competence or capabilities are a major currency of differentiation to which resources just play a part. In addition, the resource-based view suggests the development of assets in-house. In line with recent globalization and outsourcing trends, competence and dynamic capability perspective argues internal as well as external cooperation for developing or acquiring these competence/capabilities.

Table 5: Comparison of the contemporary strategic management approaches

	Resource-based view	Competence-based view	Dynamic capabilities approach
Concept of a firm	A bundle of resources and capabilities comprising: - Tangible assets - Intangible assets - Capabilities activities	An open system of asset stocks and flows comprising: - Tangible assets - Intangible assets - Capabilities managerial process	A system formed by processes, routines, and resources comprising: - Tangible assets - Intangible assets - Capabilities organizational processes
Competitive strategy	Controlling and exploiting strategic resources manifested in assets or capabilities	Deploying, protecting and developing competencies resulted from the integration of assets and capabilities	Deploying and exploiting capabilities embedded in processes, and continual reshaping of the portfolio of assets
Attributes of resources / competencies	- Valuable - Rare - Inimitable - Non-substitutable	- Valuable - Rare - Inimitable - Non-substitutable - Robust (for new market)	- Valuable - Rare - Inimitable - Non-substitutable - Dynamic
Development method	Development of intangible assets	Development and integration of intangible assets and capabilities	Development and integration of intangible assets and capabilities
Development environment	Internal	Internal and external	Internal and external
Representative authors	J.B.Barney and B.Wernerfelt	G.K.Prahalad and G. Hamel	D.J. Teece and G. Pisano

Source: Hafeez, 2002

6.3.4 Differentiation Advantage and Competitive Strategies

Competitive advantage is created by using resources and capabilities to achieve either a lower cost structure or a differentiated product. A firm positions itself in its industry through its choice of low cost or differentiation. This decision is a central component of the firm's competitive strategy.

Another important decision is how broad or narrow a market segment to target. Porter formed a matrix using cost advantage, differentiation advantage, and a broad or narrow focus to identify a set of generic strategies that the firm can pursue to create and sustain a competitive advantage.

A firm's relative position within its industry determines whether a firm's profitability is above or below the industry average. The fundamental basis of above average profitability in the long run is sustainable competitive advantage. There are two basic types of competitive advantage that a firm can possess: low cost or differentiation. The two basic types of competitive advantage combined with the scope of activities for which a firm seeks to achieve them, lead to three generic strategies for achieving above average performance in an industry: cost leadership, differentiation and focus. The focus strategy has two variants: cost focus and differentiation focus.

Figure 42: Generic competitive strategies

		Competitive Advantage	
		Lower Cost	Differentiation
Competitive Scope	Broad Target	1. Cost Leadership	2. Differentiation
	Narrow Target	3a. Cost Focus	3b. Differentiation Focus

Source: Porter, 1998

In cost leadership, a firm sets out to become the low cost producer in its industry. The sources of cost advantage are varied and depend on the structure of the industry. They may include the pursuit of economies of scale, proprietary technology, preferential access to raw materials and other factors. A low cost producer must find and exploit all sources of cost advantage. If a firm can achieve and sustain overall cost leadership, then it will be an above average performer in its industry, provided it can command prices at or near the industry average.

In a differentiation strategy a firm seeks to be unique in its industry along some dimensions that are widely valued by buyers. It selects one or more attributes that many buyers in an

industry perceive as important, and uniquely positions itself to meet those needs. It is rewarded for its uniqueness with a premium price.

The generic strategy of focus rests on the choice of a narrow competitive scope within an industry. The focuser selects a segment or group of segments in the industry and tailors its strategy to serving them to the exclusion of others.

In cost focus a firm seeks a cost advantage in its target segment, while in differentiation focus a firm seeks differentiation in its target segment. Both variants of the focus strategy rest on differences between a focuser's target segment and other segments in the industry. The target segments must either have buyers with unusual needs or else the production and delivery system that best serves the target segment must differ from that of other industry segments. Cost focus exploits differences in cost behaviour in some segments, while differentiations focus exploits the special needs of buyers in certain segments.

6.4 Case Studies Selection

This section establishes the criteria used to choose the case studies that would be analyzed in this PhD project. One decisive criterion was the use of Open Source technologies, even if the company can incorporate proprietary technologies in the final solution delivered to the customer. Other relevant criteria were the reputation of the company in the market, its international presence and capability to provide global solutions and the degree of collaboration between the company and others partners such as universities. Besides that, the physical location of the company and the availability to receive us to conduct an interview and provide technical and management information about their solutions was another important decisive factor in the selection process. We privileged the study of companies located in Portugal, but we also analyzed some important key companies in the global market. In this case, the interviews were conducted by email and through Skype.

Looking more concretely to each company, we identified the following decisive elements that supported our decision to analyze it:

- Netcall – the first Portuguese company to provide VoIP solutions. It operates in all entire VoIP value chain and it has a relevant market share in Portugal. This is the only one company that doesn't use an OS solution in their VoIP platform. However, the company uses some OS solutions such Perl, Hylafax and Joomla in their final installed solutions at the client;
- VipVoz – all the VoIP solution provided by this company is based exclusively in Open Source platforms and technologies. Besides that, the VipVoz is an important player in the north of Portugal and has strong know-how in the field of networking;
- NextStag – a company specialized to provide customized Asterisk solutions and consultancy services. The company is an important player in a very high-grow market, like it is Asia;

- Bicom Systems – one of the biggest worldwide companies to provide Open Source communications solutions. It was the first company in the world to deliver OS communications software as a professional turnkey solution. Besides that, it has a global worldwide presence with offices in Europe and USA and it has experience in the integration of OS and proprietary solutions;
- Critical Links – a spin-off company launched by Critical Software to address the networking and telecommunications market. It provides the edgeBOX, a well reputable unified communications solution for SMBs and Enterprise Branch Offices. The company has a very strong international approach;
- iPortalMais – one company that was created based in the scientific background of its management and technical team. The mission of the company is to provide knowledge in Linux systems. The company offers a compilation of several Open Source solutions in a single unified communications device;
- VoIP@FEUP – a project launched by Faculty of Engineering of University of Porto (FEUP) to migrate its traditional telephony system to VoIP. This solution was developed internally by the IT department at FEUP and contains some innovative solutions. One of the most interesting capabilities is the integration of this communications solution with the Intranet of Porto University (SIGARRA). The project has a high grow potential and already received the interest of others external entities that are already using this application.

6.5 Case Studies Analysis

6.5.1 Netcall

Short Overview of Company

Netcall is a telecom operator principally orientated to companies that privilege a cost reduction approach in their communications (voice and data), taking the advantage of their implemented infra-structure and intending to bet in new flexible and rentable solutions. The company headquarters are located in Lisbon and it has a delegation in Porto. Actually, the company is still thinking to increase their offices especially abroad and create international partnerships.

Netcall was the first company to provide voice over IP solutions (VoIP), having always developed and implemented innovative solutions integrated with IP technology. It started its activity with the development of CallShops IP and AllôShop, through a network of partnerships. In 2004, the company extended its VoIP service offer and become the first national VoIP operator.

Here, we present the most important marks of the company during its existence:

- January of 2003 – Constitution of Netcall, 'Telecomunicações e Tecnologias de Informação, Lda. with three partners: Luis Ávila, Rui Nascimento and Nuno Oliveira;
- April of 2004 – The Webware, company descended of Infopulse Portugal, Comércio Electrónico, Lda., which is especially dedicated in the development of web solutions, joins the social capital of Netcall;
- October of 2004 – Netcall looks for external financial support for the launching of its commercial VoIP project;
- June 2005 – The PME Investments is a new partner of Netcall;
- October 2005 – The management team of Netcall is reformulated and begins a period that intends to clarify the business areas of company. As a result, the company will mainly develop solutions for the VoIP market;
- March of 2007 – The Netcall extends the portfolio of products and services, launching in the market innovative solutions and the new numeration system (Netcall30). At the same time, the company invests in new strategic partnerships and in a new corporative image (web site).

The mission of Netcall is to contribute to the modernization and economic-financial competitiveness of technological Portuguese system, developing the best and most effective advanced services over IP using high-tech and pioneering technologies. It's also a mission of Netcall to promote and stimulate the utilization of VoIP with international competitive prices, taking in consideration the satisfaction and developing the loyalty of their customers.

The intention of Netcall is to keep the development and the offer of VoIP solutions and services to their customers, allowing them to reduce the communications costs. It's also a critical point to Netcall to always provide user-friendly solutions, which can facilitate the installation and utilization procedures.

The Netcall reached the break-even point during the second semester of 2006 and actually counts with more than 17.500 customers, being 500 of them companies. It was also the intention of the company to reach the level of 50.000 clients until the end of 2007 (Sargento, 2006).

In an interview, the COO of the company, Vítor Magalhães, declared that until 2009 the company wants to reach to a quote level of 10% of VoIP market, which means about 60 millions of euros. In fact, attending to some studies conducted by independent consulting companies, 12% of all Portuguese voice market will be based in IP technology. In Portugal these business values will represent about 700 millions of euros (Sargento, 2006).

However, in the end of 2008 and due to the international economic crises scenario, the Netcall presented some financial problems and declared the technical bankruptcy in December of 2008.

Open Source Solutions and Services

The portfolio of actual solutions provided by Netcall is shown in figure 43:

Figure 43: Portfolio of Netcall solutions

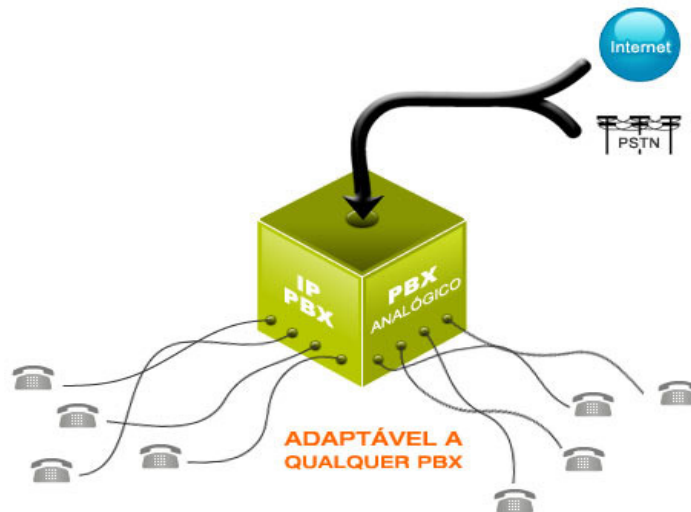


Source: Netcall.pt, 2007

NetcallVox

The NetcallVox is a Voice over IP service based on the SIP protocol, that it can be associated to a simple and efficient package oriented to reduce the costs of communications in the companies. In the most part of the cases, it is only necessary to connect a conventional phone to an adapter (ATA) which connects to an Internet connection. Other possibility is to use an IP phone, equal to conventional phone, but that connects to a net cable, or use one phone emulated by software (softphone), which makes it possible to talk by a headphone that connects directly to the input/output port of the computer voice system.

This solution takes in consideration the actual resources already available at any company, like, for example, the infra-structure of data and traditional telephony system.

Figure 44: Typical scenario of a configured NetcallVox solution

Source: Netcall.pt, 2007

The NetcallVox arguments that this solution is the most adequate to companies that wants to:

- Reduce the costs of telecommunications;
- Have low-cost solutions, even if they are simple or advanced;
- Take advantage of their actual telephony system ;
- Have a flexible solution that takes into account the development/expansion of the company;
- Make several calls simultaneously;
- Don't have specialized staff to be responsible for the infra-structure of telecommunications;
- Benefit of the mobility of solutions;
- Demand an high level of security and flexibility of the system.

The NetcallVox is associated to diverse IP solutions, like software (softphones), IP phones, IP adapters, Virtual PBX, gateways, IP communications servers and IP phone centrals.

These kinds of solutions allow the convergence of PSTN communications to IP. The advantages of VoIP are even more optimized taking into account the flexibility of the chosen solution and the level of investment.

Associated with a NetcallVox, there can exist one Service Monitoring Alarm (SMA) and the Remote Maintenance Service (RMS).

The SMA is a pro-active 24*7*365 monitoring permanent service that notifies the customer about potential problems that can have impact in its infra-structure. To each equipment included in the SMA, it is established limited values in all monitoring parameters. Using an email/SMS, the SMA will alert the customer when an equipment is disconnected or the limit values were reached.

The RMS is a functionality that allows the remote access to client devices and remotely it is possible to make all kind of necessary interventions requested by the customer.

Netcall30

The Netcall30 is a new numeration system that belongs to the National Numeration Plan (PNN), which allows the initiation and reception of calls to/from any national or international network.

The new numeration 30 comes to revolutionize the business market. With this new system it's possible to make and receive gratuity calls or a very cheap cost to any other number of the same network. The Netcall30 has a no geographic character and follows the users to any place that they go, without any others additional costs.

This solution brings some important advantages in the following domains:

- Mobility – it's possible to use the Netcall30 at home, in job or while travelling;
- Effectiveness – with the Netcall30 it's possible to be always available, being especially suitable for professional that often work outside the office;
- Economy – the numeration 30 provided by Netcall allows to reduce significantly the costs of communications. Within the Netcall network it is possible to make gratuitous calls, in the national and internal green destinations the costs are 1,7 cent/min. Another advantage point is that with this new system the roaming costs simply disappear.

The numeration come to surpass some of the disadvantages of the numeration “2”, because it doesn't have a geographic approach (it's possible to have a “30” number configured in all point of the country and abroad) and the calls can be gratuitous.

NetcallPBX

The NetcallPBX is the service that comes to replace the central phone systems of a company. It performs the functions of a traditional PBX and includes a package of innovative solutions that accomplish the business development and the demands of companies.

The NetcallPBX platform is based in the following two premises:

- All the service intelligence is allocated in the servers;
- The Netcall' clients only need to have phone terminals in their physical installations.

With NetcallPBX, and if the IVR service is configured, a call is received by an automatic answer machine, “the virtual receptionist”. The NetcallPBX allows to make all the trace of the phone call until arrives to the specified collaborator. If the person wishes, it's also possible to press the digit (0) and get a personalized answer from a real operator, which was previously designated by the company.

Here, we present a short vision of the main advantages of the NetcallPBX platform:

- Flexibility – it's possible to define in the IVR component the working time of the company, the address, alternative contacts, actualize news and events and promotions of sells;
- Personalization – each collaborator of the company has his own extension. The NetcallPBX allows an individual extension for each employee and informs the phone where he wants to answer the calls;
- Effectiveness – when a call is received, the routing call system of NetcallPBX tries to reach the specific collaborator, based in the number previously configured. If the collaborator is not available, the call will be routed to the voicemail, which will record the messages;
- Control – the Netcall system is based in the concept “client account” with one or more associated numbers. For each customer, one administrator is assigned, that can review, if needed, many of the options personalized by the employees, allowing an easy and effective control of the company system.

The NetcallPBX solution supports the following most important functionalities:

- No hardware or software is needed;
- Web management of all application;
- Monitoring of the system in real-time;
- Automatic answer of the phone calls and personalization of the messages;
- High capacity of inbox voice mail (until a max of 20 messages) and sending of these messages by email or using a web interface;
- Unlimited number of participants in the conference calls.

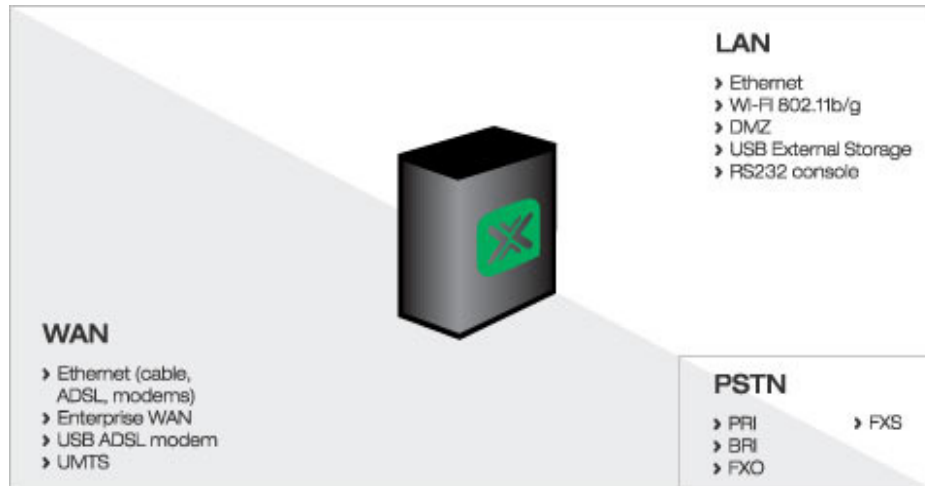
Greenbox

The Greenbox is an advanced telephony centre that integrates a large amount of voice services, data, networks and security. It allows scalability and it is especially recommend to companies that don't have specialized IT staff and wants a simplified and high-dependability telephony central. The Greenbox solutions comes with a plug-and-play installation system, which allows the remote manage of its functionalities.

This advanced solution of dedicated IP services allows the increment of the profitability and efficiency of companies, enclosing in a single device all the functionalities that the customers need, based in a converged network platform.

Each feature of the Greenbox is controlled by the remote web management interface. It is offered an initial configuration personalized to the company, or in alternative, a template can be picked from the pre-established list, reducing the time of installation.

The development of Greenbox was based in a modular concept and it is based in standard certified hardware. It allows the integration of LAN, WAN and gateway VoIP (see figure 45).

Figure 45: Schema of integration services (LAN, WAN, PSTN)

Source: Netcall.pt, 2007

The Greenbox includes a full telephony IP centre (IP PBX), where it is available all the expected function of a telephony central, like IVR, Automatic Call Distribution (ACD), digital receptionist, rules to income voice calls, sound management, routing tables, conference calls and management of users.

To assure a good quality for the VoIP calls, the Greenbox provides mechanisms of Quality of Service (QoS) management, reserving a percentage of bandwidth to voice or guarantying that the voice traffic will be answered before the data (high priority traffic).

NetcallFax

The NetcallFax application allows the customer to receive faxes by email, eliminating equipments, fax servers, dedicated lines and long distance costs. The fax messages are directly sent by a web interface and are received in the email address. The user has the possibility to check and confirm the faxes that he received.

The NetcallFax brings the following advantage to the consumer:

- Reception of fax by email – based in an email address the faxes are sent by Internet;
- Costs reduction – the company predicts a very low cost to use this service. During the actual promotion phase the use of this service is free;
- Service monitoring – allows the visualization in real time of the faxes received using a web interface;
- Client support – the Netcall offers the support for the client based in a web address and a physical phone call available five days per week.

This service will give the same operations that are already provided to the receive faxes operation. This functionality enables to reduce about 40% of the total costs to support and maintain a fax line and eliminate the consumption of paper (Netcall.pt, 2007).

NetcallWeb

The NetcallWeb is a complete service to create and management of a web site allowing the customer to create professional web sites in just few minutes. Without the need of a professional package to create a web page, it is possible to update a web site using any computer at any place.

This service is based in an advanced platform of content management, the Joomla, which easily adapts the business of a company to a web platform. The NetcallWeb is entirely customized to the client following a modular approach. Therefore, the customer can personalize each web site based in exactly what he needs, adopting only modules that really make sense to use in his business area.

The NetcallWeb is used by many companies in the following domains: e-commerce, industry, telecommunications, franchising, public administration, clinics and public/private associations.

The NetcallWeb platform brings the following advantages:

- Independence – it is possible to create a web site using any web browser at any part of the world;
- Quickness – the website basics can be done in just few minutes;
- Image – the image of the website can be based in thousands of templates already available;
- Security – the company offers a secure area to keep the web page, documents and photos;
- Simplicity – there is no need to transfer FTP files to the web-server;
- Hosting – it includes hosting feature to manage web sites;
- Support – the company has a professional team available to help in the creation of the website and to answer the doubts of the customers.

Clients

The major clients of Netcall are:

- Mota Engil;
- Teixeira&Duarte;
- Grupo Amorim;
- Call centers.

We will look with more attention to a VoIP project system developed by Netcall to a call center.

YourVoice

YourVoice was the first Contact Center in Portugal with an infrastructure based in VoIP. The company was launched in the end of 2006 and now the company has about 50 operators that work in turn-shifts. The company assumes itself as a provider of telemarketing inbound and outbound services and also as a company specialized in the management of SMS, e-mail and fax.

The use of VoIP technology was established since the beginner, because it was always the desire to create a company with some differentiate and innovative concepts facing the actual market offer (Delgado, 2007).

The investment in VoIP infrastructure was reduced. They invested about 250 thousand euros in the creation of company, and only 50 thousand euros were spent in the technologic infrastructure. The implementation was totally managed by YourVoice and the tests of Netcall and Altitude Software were deployed remotely, attending to the fact that the solution was already tested and certified. The YourVoice needed two servers Dell PowerEdge 1950 and one router Cisco 1700 Series. It was also their choice to used IP Polycom SoundPoint telephones. YourVoice was responsible to choose these equipments, but it also received some important inputs from NetCall.

Ricardo Delgado (CEO of YourVoice) admits that the results were very positive. He says that the solution is very flexible and the broadband is the only requirement that limits the amount of calls that the company can deal simultaneously.

The company is economizing much money in telecommunications, based in the agreement established between Netcall and YourVoice, which turns possible to make calls using very competitive prices. Besides that, the implementation of this solution by YourVoice gave to the company some important reputation in the market.

Competitive Advantages and Business Strategy

The Netcall has the following core competences:

1. Customization of solutions;
2. Operating in entire VoIP value chain;
3. Partnerships with Telecom companies;
4. Partnerships with vendor agents;
5. Partnerships with suppliers of networking equipment;
6. Use and integration of open-source and commercial solutions;
7. Competences in the financial management fields;
8. Success of implementation of AllôShop and virtual kiosks concept;
9. Network contacts of company.

Based in these core competences, we can formulate its competitive advantages, which can be supported in the following 4 levels:

- Brand reputation [3, 4, 8, 9] – Netcall was one of the first companies to operate in the VoIP field. The success to implement the concept of virtual kiosks and AllôShop give to the company some important initial customers. Besides that, the vendors agents are responsible to make some marketing campaigns of their products and this increase the visibility of the company;
- Complete VoIP solution [1, 2, 6] – Being a VoIP operator and services provider give to the company competences and distinctive positioning in the VoIP value chain. The company can offer a full featured solution with low prices of communications;
- Partnership network [3, 4, 5, 9] – The company has an established group of partners. With these partnerships network, it is possible to offer more complete solutions with competitive prices. Also, the partnership with InterTalk gives the company the opportunity to use its infrastructure of communication. However, this same partnership doesn't allow Netcall to offer its own technology and can decrease the innovation process for the creation of new technology services;
- Low price of platform and communications [2, 3, 5, 6] - The prices offered by Netcall solution are usually cheaper than other companies, especially in terms of VoIP communications.

The Netcall intends to follow a strategy that simultaneously gives importance to the component of price and differentiation. The company does not intend to be a leader in these two domains, but intends an harmonized mix between them. Netcall acts in a concise geographic market with Portuguese and PALOPs customers. The Netcall solutions address preferentially the business-market, where they can develop personalized and more value-added solutions. However, the VoIP solution is also available and used by residential clients.

Conclusion

Netcall was the first Portuguese company to provide VoIP solutions, based in its previous activity to development of CallShops IP and AllôShop concepts, through a network of partnerships. The Netcall reached the break-even point during the scnd semester of 2006 and actually counts with more than 17500 customers, being 500 of them companies, including some of the most important Portuguese companies like Mota Engil and Amorim Group.

The Netcall operated in all entire VoIP value chain, which gives to the company competences and a distinctive positioning against some of its competitors. This core competence enables the company to offer a full featured solution with low prices of communications. At the same time, the implementation success of AllôShop and virtual kiosks concept increased the brand reputation and gave visibility to the company, when the use of VoIP connection was still in its infancy at Portugal.

The Netcall acts in a concise geographic market, targeting the Portuguese and PALOPs business market companies. The company follows a strategy based both in price and differentiated services.

More information about Netcall and some documentation provided by the company can be found in annex H.

6.5.2 VipVoz

Short Overview of Company

The VipVoz is a recent company located in Guimarães operating in the telecommunications field that was created as a spin-off from the Viptrade, a textile company. The Viptrade imported goods from Asia to Portugal and it had high telecommunications bills. Based in this fact, one of the partners thought that the VoIP could have been a good solution (Brito, 2006).

In technical terms, it was developed a system where the utilization of telephone would be processed following a traditional approach, not depending on a computer or headphone, to decrease the eventual resistance to change and to increase the speed and efficiency of the adoption process. The phase of research & development of the new product took place during October of 2004 and June of 2005.

The experience of this solution at Viptrade worked very well and the company started to think to commercialize this platform to other companies (Brito, 2006). The license from Anacom arrived on July of 2005 and the commercialization process started on October of 2005. Three months later, the company already counted with about one hundred of customers (Brito, 2006).

The VipVoz was the first VoIP operator to provide Voice over IP solutions to all international destinations recognized by Ministerial Services of Labour and Social Duties (MTSS).

The goal of VipVoz is to provide a complete personalized service of VoIP to the communications needs of a company. The VipVoz intends to be competitive, offering low rates of communications, essentially for international calls.

The VipVoz operator is a national operator targeting only the business-related market. The CEO of VipVoz, explains that with the VoIP solution of VipVoz, it is possible to decrease in about 80% the costs of international calls and in 40% the costs of national calls. Following the vision of Marco Teixeira (CEO of VipVoz), a medium size company can get the return on investment in just two or three months.

Open Source Solutions and Services

The portfolio of actual solutions provided by VipVoz is composed by the following:

- VIP Connect;

- Web hosting service;
- E-mail hosting service;
- VPN server;
- Network security.

VIP Connect

VIP Connect is the VipVoz solution in the area of voice over IP. It was developed by using some Open Source platforms and technologies, namely:

- Asterisk;
- SIP;
- OpenSER;
- Python Programming Language;
- MySQL.

The Python language was used to customize some additional functionalities and to integrate the OpenSer solution with the Asterisk. MySQL database was used to manage the authentication of the users in the system.

The OpenSER is used in Vip Connect to provide the following capabilities:

- Make the IP corrections of “contact header” and “SDP header” and implementing a transversal NAT;
- Managing the SIP signalling when two VoIP users are talking with each other;
- Execute the re-routing of phone calls in case of failure;
- Send users to the voicemail of Asterisk’s application.

OpenSER is especially designed to manage and deal with SIP signalling. It would be possible to make the same tasks using only the Asterisk, but the performance of the overall system would be lower. In VIP Connect the OpenSER is used as a proxy of the network. Thus all internal branches and SIP calls from external networks can be received by OpenSER. As a result, only when the user needs a more advanced PSTN resource the call will be redirected to Asterisk.

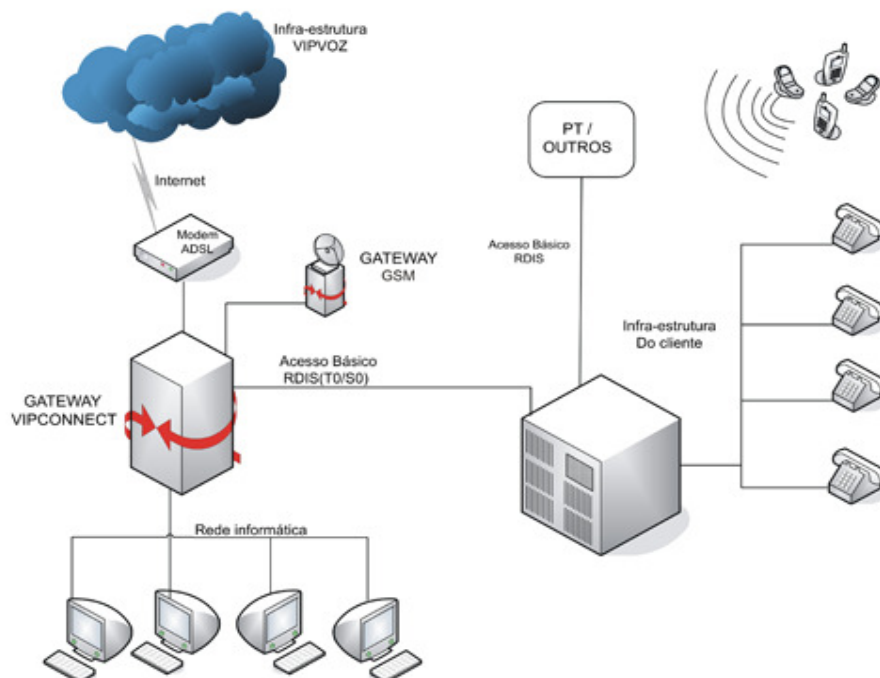
The Vip Connect provides the most typical features that we can find in a VoIP solution, respectively:

- Caller ID identification;
- Call waiting and call forwarding mechanisms;
- Voicemail;
- Message notification.

The VIP Connect uses an hybrid communication system, because it keeps the connection to traditional voice systems to implement redundancy mechanisms. In case of problems with the Internet connection (e.g., break of electric energy), the Vip Connect redirects the calls to the fixed traditional network. This system has still the advantage of allowing the client to keep the existent capacity of communications channels, added the output channels of VoIP.

Figure 46 presents a typical architecture of a communication system, with the VIP Connect solution installed.

Figure 46: Typical communication scenario using a VIP Connect solution



Source: VipVoz, 2008

Attending to the figure 46, when the user establishes a phone call from his usual phone, the call is routed to the VIP Connect equipment, which transforms the voice in data packets that can be carried by the Internet until the VipVoz centrals. Consequently, after the treatment of these data packets, they are sent to a VipVoz partner, located closest to the receiver of the call. The supplier reconverts the data packets to voice and establishes a local call to the receiver, establishing the transmission route between the sender and receiver.

The introduction of a GSM gateway enables direct routing between IP, digital, analog and GSM networks. With these devices (fixed cellular terminals) companies can significantly reduce the money they spend on telephony, especially the money they spend on calls from IP to GSM.

Web hosting service

A web hosting service is a type of Internet hosting service that allows individuals and organizations to provide their own websites accessible via the World Wide Web. VipVoz is either a web host company that provides space on a server to be used by its clients as well as providing Internet connectivity to a data center.

The scopes of hosting services vary widely and can be chosen based on the following plans:

- Micro plan – ideal for companies that want to have a presence in the Internet;
- Standard plan – ideal for a professional site with the need to have a good amount of characteristics with a very competitive price;
- Professional plan – ideal for companies that want to have a strong presence in Internet with much activity;
- Business plan – ideal for web complex page companies that have a lot of content and resource needs.

The VipVoz uses a shared web hosting server approach to its web hosting plans. The web site of the company is placed on the same server as many other sites, ranging from a few dozens to hundreds. Typically, all domains share a common pool of resources, such as RAM and the CPU. The user doesn't have a full control of his website (root access for Linux/administrator access for Windows) like in a dedicated hosting service approach. However, they are allowed to manage their data via FTP or via cPanel. The provider can guarantee quality of service by not allowing the user to modify the server or potentially create configuration problems.

E-mail hosting service

VipVoz works as an e-mail hosting provider offering an advanced premium-email solution hosted on dedicated custom e-mail platforms. The VipVoz supports SMTP, IMAP and POP3 based-emails and a webmail based on Open Source webmail application like Horde and Squirrelmail.

The email packages offer a business great value, feature-packed email solutions that present a professional email address and meet the demands of professional users. The user might choose the amount and the size of each e-mail account that he needs.

The e-mail hosting service provided by VipVoz has the following advantages:

- Business is protected with anti-spam & anti-virus – the spam mechanisms avoids the reception of junk emails and the anti-virus service is responsible to remove all known virus before they reach to inbox. The virus definitions are updated every hour by Kaspersky Labs, the world leaders in anti-virus technology;
- Full control with domain manager – this service gives a powerful feature such as URL cloaked/uncloaked URL forwarding and zone file management;
- Unlimited support – the support is provided by a technical support team with just a phone call away.

VPN server

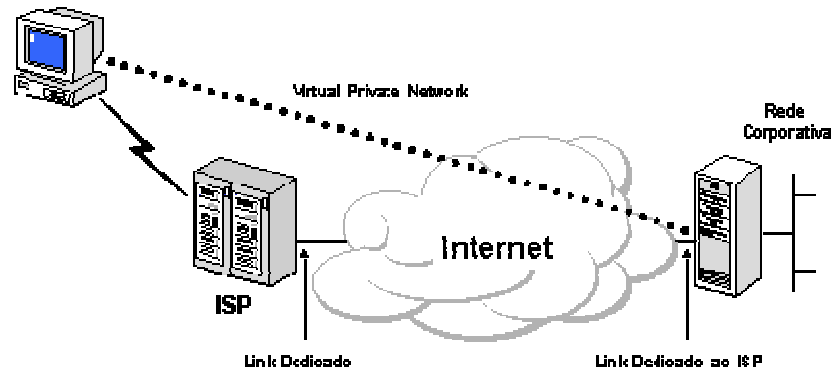
The VipVoz provides a Virtual Private Network (VPN) that turns possible for the users to remotely access to the infra-structure of the company. The use of a VPN represents an interesting alternative for the rationalization of costs in corporate networks offering confidentiality and integrity on the transport of information through public networks.

The idea is to use a public network like the Internet, instead of private lines, to implement cooperative networks creating a VPN. The VPNs are tunnels of cryptography between authorized end-points, created through Internet or other public and/or private networks to transfer information, in a secure mode, between corporative networks or remote users.

The VipVoz provides a VPN server that allows the following features:

- Users authentication – verification of user identity and denial of access to no authorized users. It has audit mechanisms providing information about all the registered accesses;
- Address management – the client address of his private network shall not be divulged. The VPN server adopts fakes IP addresses to deal with external traffic;
- Data cryptography – the data is always transferred in a codified mode, and, even if they are stolen by no authorized persons, it can't be decoded. Only the authorized users can access the message contents;
- Keys management – the user of private and public keys assures the security of the cryptographic messages. The exchange process of these keys is done periodically to maintain the security of the communication;
- Support to multiple protocols – the VPN supports the standard protocols of public networks, like IP and IPX (Internetworking Packet Exchange).

The remote access to corporate networks through Internet can be done by a VPN using a local connection to an Internet Service Provider (ISP). The remote station contacts the access provider and connects to the Internet. Now, the VPN creates a virtual private network between the user and the corporative VPN server through the Internet (see figure 47).

Figure 47: Remote access through the Internet

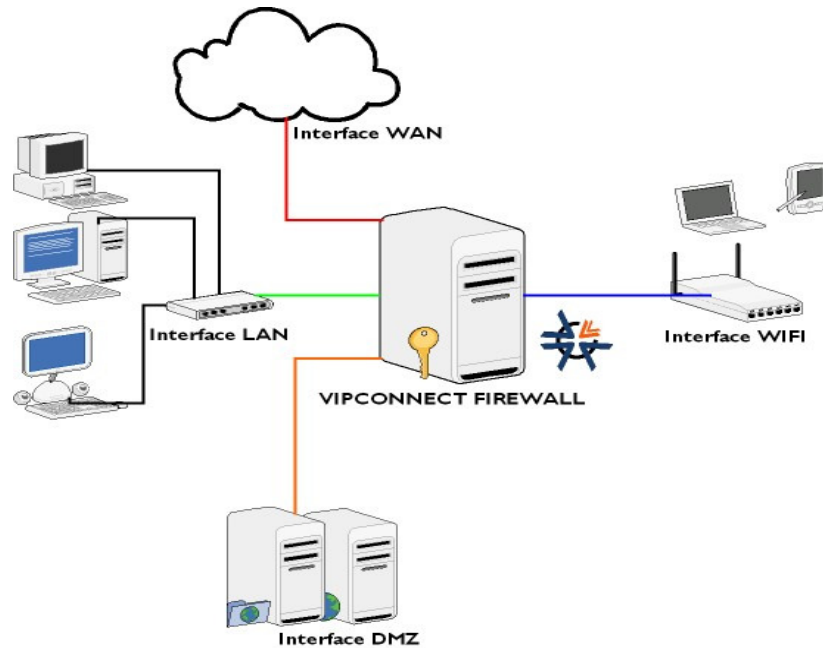
Source: VipVoz, 2007

Network security

The VIP Connect Firewall is a very complete tool that turns easier all the management process of security, connectivity and networking. The VIP Connect Firewall implements the following features:

- Protection from spams and virus – with the POP, SMTP and HTTP proxies and the antivirus and anti-spam tools, all the network machines, as well as the electronic mail gains an extra shelter, avoiding future irreparable problems in the network;
- Interconnection of two or more branch offices – using a VPN connection it is created an encrypted tunnel between two or more Internet endpoints that allows to work remotely using the private network of the company;
- Protect the network against possible outside attacks – the VIP Connect Firewall includes an IDS system to detect, block and register outside attacks to the network of the company;
- Control and management of network traffic – using the traffic shaping, the management process of the QoS and NAT of the FirewallVIP Connect is done easily. It is possible to manage the network bandwidth establishing different priorities for each service and machine. It's also possible to create DMZs isolating the network from possible attacks to the hosted services;
- Restrict the user access to the network – it's possible to filter the user access to some external contents. Content and URLs filters can be used to specify the services and schedules that there will be available.

Generically, the architecture of the VIP Connect Firewall is shown in figure 48.

Figure 48: Overview of VIP Connect Firewall architecture

Source: VipVoz, 2007

The VIPConnect Firewall controls and registers all the outside traffic to WAN networks. At the same time, it supports an interface to WiFi and Local Area Networks (LAN) machines controlling the access to the information. Finally, the DMZ is a firewall configuration for securing LANs. In this DMZ configuration, most computers on the LAN run behind a firewall connected to a public network like the Internet. One or more computers also run outside the firewall, in the DMZ configuration. Those computers on the outside, intercept traffic and broker requests for the rest of the LAN, adding an extra layer of protection for computers behind the firewall.

Clients

VipVoz has some important clients located in the north of Portugal. In this geographic area, there are some important industrial companies that work essentially in the export trade. We can mention the following clients of VipVoz:

- TorresTIR;
- LusoCargo.

Besides that, the company won an important public competition to develop the VoIP system in the Ministry of Labour & Social Security.

Recently, the company is involved in other big project, not only important in financial terms but also for the strategy of the company. The VipVoz is moving its installations for the new IDEIA Atlântico complex located in Braga. This is a big challenge for the company, because it will be responsible to define and equip all the VoIP system in the building. It will be the

proof of their capabilities for one of most important technologic parks in the Western Europe.

Competitive Advantages and Business Strategy

The VipVoz is a small and medium size company that presents the following core competences:

1. Deep knowledge in the field of networking;
2. Competences in the field of development and use of Open Source software;
3. Offering of complementary solutions in the field of networking connection provider and security systems;
4. Mechanism of “failover relay” to forward calls routing;
5. Partnerships with suppliers of networking equipment and providers of VoIP hardware;
6. Dedication and technical competence of its work team;
7. Past experience and contacts in networking of its management team.

Based in these core competences, we can formulate its competitive advantages, which can be supported in the following 7 levels:

- Integration of several open-source solutions [1, 2, 3, 5] – The VIP Connect solution use several technologies in the domain of Open Source. Asterisk project is one of the platform sources, but the solution also uses other Open Source tools like: OpenSER, MySQL and SIP. The VIP Connect is a totally 100% Open Source solution;
- Simplified use and configuration of VoIP system [1, 2] – It’s possible to keep the same old infra-structure of communication. All the contacts, extensions and methods of communications remain the same;
- Performance of the VIP Connect solution [1, 2, 3, 5] – The VipVoz only use equipment and established connections with high reliability providers. Usually, the price of the solution is more expensive than others VoIP companies, but the quality of communications is better. Besides that, a typical solution implemented by VipVoz consists on the evaluation of the networking performance in the client. If the company detects that this performance is low, the VipVoz proposes to the client to use other Internet provider, which integrates its partner network;
- Reduction of the time of network inactivity [3, 4] – The client can always make calls using the VoIP connection or the traditional PSTN connection. Usually, if the VoIP connection is available and offering a good performance quality, the calls goes by this network. However, it’s always possible to redirect all the calls by the PSTN lines;
- Flexibility and agility of the company [5, 6] – VipVoz is a small size company that can easily attend new requests of the customers. The mission of its activity is to offer a

good service to its customers. With the establishment of partnerships with other VoIP hardware providers, the company can offer more complex solution for its customers;

- Relationship with the client [6, 7] – Most part of its clients are medium and big companies in the industrial market. This market demands a close relationship with the client and a big agility to attend the specific requirements. Besides that, the VipVoz was created as a spin-off of a textile company. This background facilitates the relationship with other industrial companies;
- Technical support [6] – All the staff of VipVoz is speciality devoted to attend the requirements of the customers with high priority.

The VipVoz intends to follow a strategy based in the leadership by differentiation acting in a concise geographic market. The goal of the company is to attend only the business-related market, especially the industrial segment. The VipVoz intends to be competitive, offering low rates of communications, essentially for international calls. However, there isn't a consistence approach to minimize the costs of VoIP calls and equipment to their clients, taking in account other companies and VoIP operators.

Conclusion

The VipVoz is a recent company located in the north of Portugal that launched its activity on June of 2005. It operates in the VoIP telecommunications field and was created based in a spin-off from the Viptrade, a textile company. Firstly, the company only intended to create an internal VoIP telecom solution, but soon they started to think to commercialize the platform to other companies. Currently, the company has some important clients located in the north of the country, namely industrial companies that work essentially in the export trade.

The portfolio of the solutions provided by VipVoz includes the following packages: VIP Connect, Web hosting service, E-mail hosting service, VPN server and VIP Connect Firewall. The VIP Connect is based exclusively in Open Source platforms and technologies like OpenSER, MySQL and SIP. The web hosting and e-mail services offer an Internet and e-mail accounts services for a company. The VPN server provides a remotely access to the infrastructure of the company. Finally, the VIP Connect Firewall is a complete tool that supports security, connectivity and network management for the broadband connection of the company.

VipVoz has strong know-how in the field of networking, which turns possible to provide a robust solution to its customers. At the same time, the company offers a package of complementary solutions in the field of networking connection provider and security systems, in order to offer a simplified and configuration VoIP system. The solution provided by VipVoz keeps the same old infra-structure of communications, what simplifies the migration process to a VoIP solution.

Another important competitive advantage of the company is the strong relationship with the client. Most part of its clients are medium and big company in the industrial market. This

market demands a high close relationship with the client and a big agility to attend the specific requirements.

The VipVoz intends to be a competitive player that offers low rates of communication, essentially for international calls. The intention of the company is to focus only the business-related market, especially the industrial segment located in the north of Portugal. It follows a strategy based in the leadership by differentiation acting in a concise geographic market.

More information about VipVoz and some documentation provided by the company can be found in annex I.

6.5.3 NextStag

Short Overview of Company

Headquartered in New Delhi, NextStag is a global provider of high quality and cost-effective VoIP based telecommunications solutions. NextStag offers a range of expertise aimed to help its customers, engineer and re-invent their business using VoIP, to compete successfully in an ever-changing marketplace.

NextStag prides itself in using Asterisk and SER to base its products upon, which have reshaped the world of telecommunications, and the way communication is carried out. The company bouquet of products includes VoIP communications solution, billing and softphones.

NextStag also provides VoIP consultancy regarding network and telecom solutions deployment and integration. Its Asterisk contractors have expertise in developing distributed Asterisk systems for both small businesses and large corporate deployments. The company is specialized in providing high-level Asterisk support to customers with standard implementations and highly customized Asterisk solutions.

Open Source Solutions and Services

NextStag has available a wide range of products and services, namely:

- NextStag VoIP Billing;
- NextStag IP PBX;
- NextStag Calling Card;
- Softswitch;
- NextStag CallBack;
- NextStag CallShop;
- NextStag Softphone;
- SER – SIP Express Router;

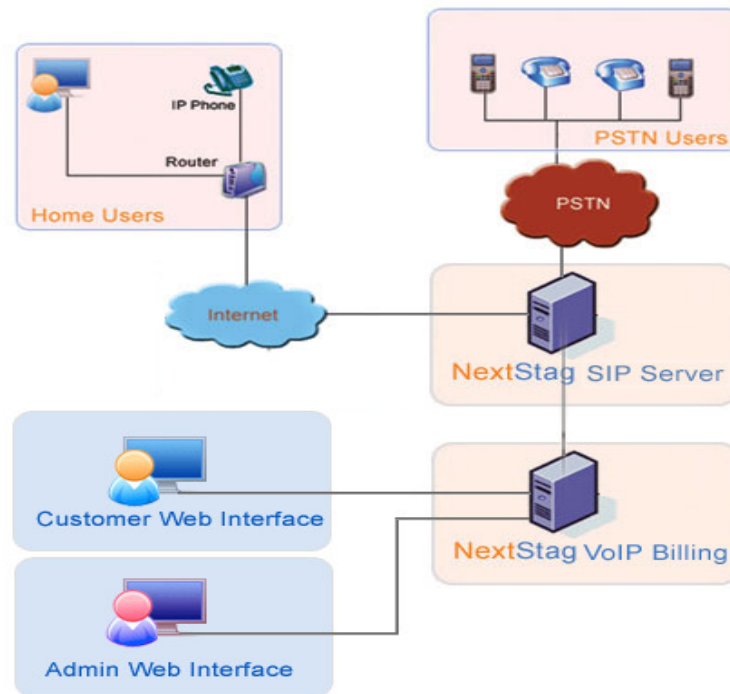
- NextStag Asterisk Services;
- Asterisk IVR and Dial Plan Designing.

NextStag VoIP Billing

NextStag VoIP Billing is a fully featured billing system running on an Asterisk server for prepaid, postpaid and regular phone calling card, pc2phone and ipphone2phone services. It includes telephony service logic platform, user management, web-based customer signup, automatic PIN creation and authentication. The system also includes a real-time rating engine with self contained billing, reporting and statistics.

NextStag VoIP Billing has a modular architecture, like shown in figure 49.

Figure 49: Technical architecture of NextStag VoIP Billing



Source: NextStag, 2007

The features list can be split into two sections: web management interface and customer interface. The web management interface provides functions like billing management, powerful rate-engine, DID selling and reporting. The customer interface provides functions like call history, voucher usage and rate-card browsing & simulator.

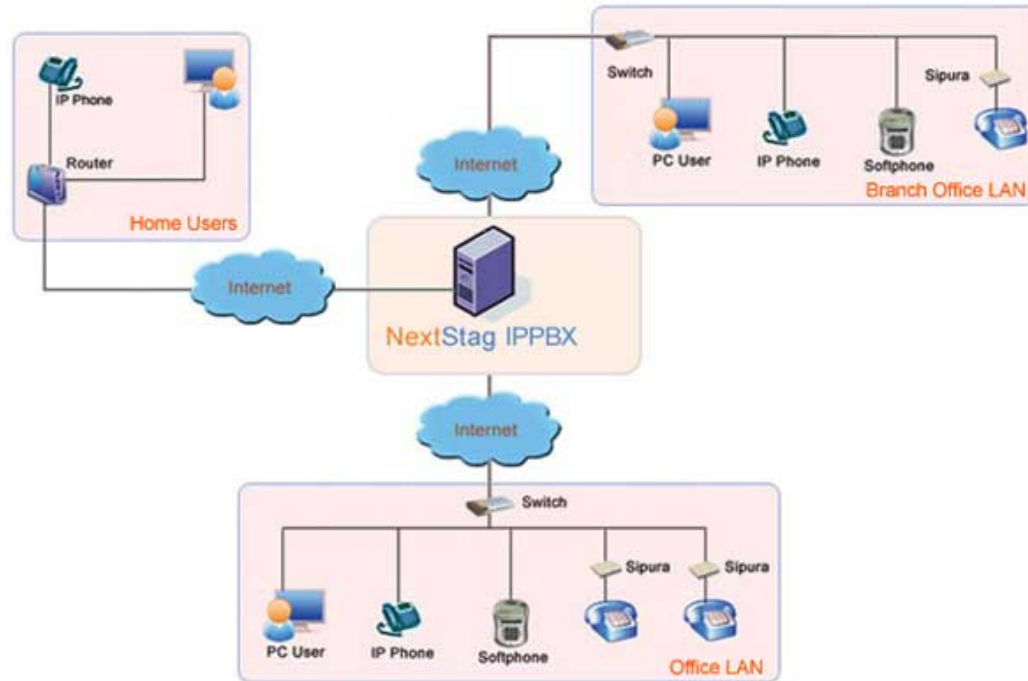
NextStag IP PBX

NextStag offers a rich and flexible featured IP-PBX. NextStag's IP-PBX offers both classical PBX functionality and advanced features, and interoperates with traditional standards-based telephony systems and Voice over IP systems. NextStag offers the features one would expect

of a large proprietary PBX system as Voicemail, Conference Bridging, Call Queuing and Call Detail Records.

In figure 50, we present a global vision of the system architecture.

Figure 50: Technical architecture of NextStag IP-PBX



Source: NextStag, 2007

This solution provides a full package of features in the following domains:

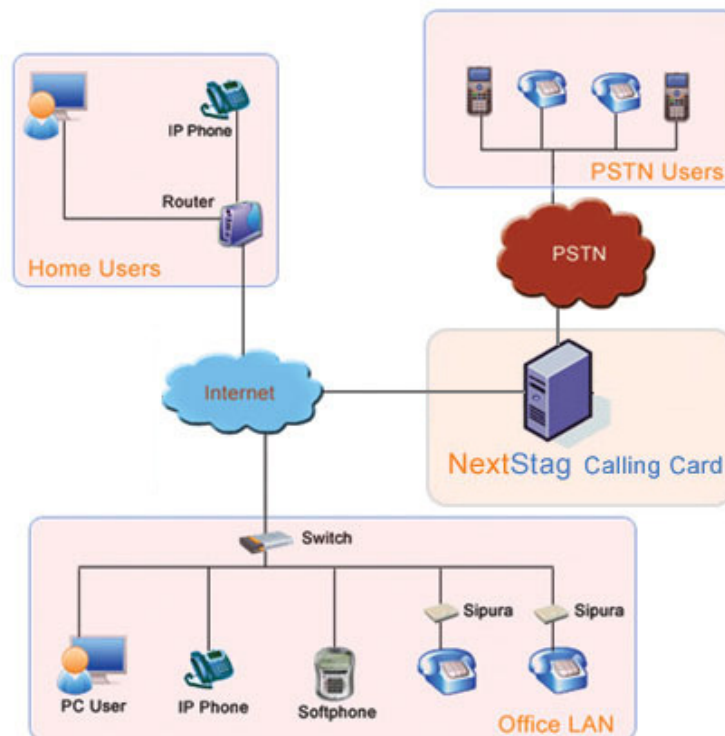
- Call features – authentication, call forward, privacy and voicemail;
- Scalability – Time Division Multiplex over Ethernet (TDMoE) that allows a unified dial plan across multiple offices;
- Codecs – ADPCM, G.726, G.729 and GSM;
- Protocols – IAX, H.323, SIP and MGCP;
- Traditional Telephony Interoperability – E&M, FXS and MF&DTMF support;
- PRI protocols – 4ESS, BRI(ISDN4Linux) and NFAS.

NextStag Calling Card

NextStag's Turnkey VoIP Calling Card solutions offers lower cost international calling solution altogether providing everything one needs to quickly generate revenue from a calling card business. NextStag Calling Card supports Caller ID and Card Number, Automatic Number Identification (ANI), DID Based Authentication Mode, with a simple and intuitive user interface.

NextStag Calling Card has the modular architecture shown in figure 51:

Figure 51: Technical architecture of NextStag Calling Card



Source: NextStag, 2007

This solution provides the following most important features:

- Management features – generation of prepaid and postpaid based accounts and web based user account management;
- Control features – credit balance prompt with multi currency support, call recording and prefix configuration facility;
- Tariff management features – activation fees and assignment different rates to different cards or customers;
- Web interface – call history, recharge card and web callback;
- Card reports – CDR reports, monthly traffic and graphical reports of call details with call records;
- Billing features – real time billing and support of multiple carriers for prevention failover.

Softswitch

NextStag Softswitch is a fully featured Softswitch system running on an Asterisk server. It is an API that is used to bridge a traditional PSTN and VoIP by linking PSTN to IP networks

and managing traffic that contains a mixture of voice, fax, data and video. It is able to process the signalling in SIP/IAX protocols.

NextStag Softswitch is simple to manage by Web, which can be put in service with minimal training of the helpdesk and operations staff. It provides to his customers, instant access to SIP/IAX usage information, traces from CDR level to protocol level, statistics grouped by criteria like release cause, destination or billing parties and can also help determine the source of SIP/ISDN call flows failures. By using NextStag Softswitch a company can lower to almost zero the response time of their customers support centre for VoIP related problems.

Using an on the fly rating engine based on exceptions, different rates may be applied per subscriber, domain or gateway. The rates are linked with profiles corresponding with different time of the day, day of the week or holidays. For rating calls which span multiple profiles, the right rate is selected and applied for the call duration within each profile. Each customer may be assigned its own dedicated rating plans destination identification and names. Multiple time-zones are supported for multiple billing parties hosted on the same platform. Different fees may be applied based on application type (video or audio).

NextStag CallBack

NextStag offers a callback service for VoIP businesses. While in a typical call the caller dials the called party directly, using a callback scenario, a callback server dials the caller, obtains a destination number via a callback system, dials that number and connects the call. Because of the reversed call path and utilization of VoIP technology, VoIP service providers can save money and also can pass some of those savings to the entrepreneurs who want to enter the VoIP market.

NextStag CallBack Solutions includes multiple callback methods: phone, e-mail, SMS, web and Dialed Number Identification Service (DNIS), integrated with NextStag Calling Card and VoIP Billing. VoIP service providers can integrate and deploy callback solutions with NextStag Calling Card and VoIP Billing.

This solution has the following components and requirements:

- NextStag Billing: an Asterisk based billing server that supports a pre- and post-paid VoIP billing, including CallBack;
- NextStag CallBack gateway: with CallBack modules;
- E-mail gateway and SMS Server gateway.

This solution allows customers in locations where international dialling is blocked, when VoIP ports are blocked in Internet and where customer is not reachable.

NextStag CallShop

NextStag CallShop provides a feature rich platform for outbound calls to call-shop owners. NextStag CallShop provides a platform from where a customer can make domestic or

international calls. This application has a powerful billing system to bill all the calls made through various booths of the call-shop. NextStag CallShop comes with a user friendly web interface, which allows the user to manage the booth, see the active calls, check the billed amount and see the call statistics ordered by booth. Call-Shop simplifies the process of owning, managing and billing the user customers at his call shops.

NextStag Softphone

The NextStag provides its own softphone solution that allows the user to talk using VoIP without necessary having a physical phone set. This solution is a piece of software that acts as an interface allowing the user to dial numbers and carry out other phone functions using a screen of a computer or PDA device.

NextStag Softphone is designed on industry standard SIP protocol to make it compatible to almost all service provider. It supports a range of codecs: G711, G723, G729, iLbcs and GSM. STUN and NAT support make it working even under a firewall.

The user interface resembles a phone with buttons representing the keys and can be easily customized. It is possible to choose one of the existing softphone skins or a new one can be designed for the user private branded softphone.

SER – Sip Express Router

SIP Express Router (SER) is a high-performance and configurable free SIP server. It handles thousands of calls per second on low-budget hardware. A C shell-like scripting language provides full control over the server's behaviour. Its modular architecture lets users load only the required functionality.

Its performance allows it to deal with operational burdens, such as broken network components, attacks, power-up reboots and rapidly growing user population. SER is written in C and has been ported to Linux (PC and IPAQ) and Solaris (Sun). SER's configuration ability meets needs of a whole range of scenarios including small-office use, enterprise PBX replacements and carrier services.

NextStag Asterisk Services

NextStag provides customization and configuration including installation and commissioning of asterisk and SER based applications and networks.

The company can be responsible for the configuration of the following asterisk features:

- Configuration of ZAP channels – the NextStag provides an interface layer between Asterisk on the one side, and the Zaptel interface drivers on the other side. These drivers, in turn, provide the ability to use interface cards to connect the PBX of an enterprise to traditional digital and analog telephonic equipment;

- Configuration of VoIP providers for PSTN termination and origination – generally phone service via VoIP costs less than equivalent service from traditional sources. Therefore, people use VoIP providers to terminate international calls. NextStag has experience in configuring various SIP, IAX2 and H.323 termination providers;
- Configuration of extensions – the company can configure SIP/IAX2/H.323/ZAP extensions for the customer. After creating extension, the user can connect soft or hard phone to Asterisk and start calling;
- Configuration of Automatic Call Distributor (ACD), Agents and Queues – the company offers a professional service to set up a inbound or outbound call center;
- Configuration Find me, Follow me – the company configures the service that allows to receive the calls in the extension of the user. If the user is not available, it will ring to the user cell phone or PSTN phone, and finally goes to voicemail if no one answers the call;
- Configuration of Meet me – offers the possibility to configure conference rooms with and without pin numbers;
- Configuration of Voicemail – Asterisk has the ability to store voicemails and send them as an attachment to configured email addresses. The company can configure voicemail accounts with users email addresses.

Asterisk IVR and Dial Plan Designing

Interactive Voice Response (IVR) is the technology that lets the user to interact with a menu using a touch-tone telephone. It is very easy to set-up such a menu with Asterisk. In telephony, IVR is a computerized system that allows a person, typically a telephone caller, to select an option from a voice menu and otherwise interface with a computer system.

IVR systems can be used to create and manage many services including telephone banking, order placement, caller identification and routing, balance inquiry and airline ticket booking. Voicemail systems are different from IVR systems in that they are a one-way communication tool (the caller leaves a message), whereas IVR systems attempt two-way interaction with the caller. Automatic call distributor (ACD) systems are often the first point of contact when calling many larger businesses, and can be used in place of more expensive IVR systems. IVR systems are generally used at the front end of call centers to identify what service the caller wants and to extract numeric information such as account numbers as well as providing answers to simple questions such as account balances or allow pre-recorded information to be heard.

For example, banks and credit cards companies use IVR systems so that their customers can receive up-to-date account information instantly and easily without having to speak directly to a person. IVR technology is also used to gather information, as in the case of telephone surveys in which the user is prompted to answer questions by pushing the numbers on a touch-tone telephone.

Dial-plans can be defined in *extensions.conf* file or database using real-time configuration in Asterisk. Basic Asterisk dial-plans can be defined easily in no time, but the creation of Asterisk dial-plans for billing solutions, call center solutions, IVR or any other custom application is not so easy. NextStag has an expertise in creating complex Asterisk dial-plans, with large experience in the creation of dial-plans for billing solutions and conferencing systems.

Clients

The NextStag provides communications solutions for the regional and domestic enterprise markets. In the commercial market, the company is especially interested in addressing companies located in the Asia that intend to provide VoIP communications to their clients. Some of these companies include:

- Masfone;
- Axis Convergence;
- e-talk;
- Talkitel;
- Ifoon.

Competitive Advantages and Business Strategy

The major core competences of NextStag are:

1. Deep knowledge of Asterisk platform;
2. Modular architecture of components;
3. Complete and full-featured billing solution;
4. Management interface;
5. Own softphone solution;
6. Customization and scalability;
7. High performance using SER;
8. Strong web presence.

Based in these core competences, we can establish its competitive advantages, which can be supported in the following 6 levels:

- Performance and high level of functionalities [1, 2, 3, 7] – The VoIP solution provided by NextStag includes a high level of features in the area of Billing, PBX, Calling cards, CallBack system and CallShop. Besides that, the use of SER gives the possibility to use a high-performance and configurable SIP server;

- Simplified configuration of management features [2, 4] – It's easy to configure all the rich management features like prepaid and postpaid accounts, credit balance, tariff management and card reports;
- Easily customizable [2, 4, 6] – The customization of all system is easily done using its web interface;
- Solution scalability [2, 6] – Due to its modular architecture it's easy to add new features and include it in a new module or update it inside a used version. Each module has its own version control management.
- Full statistics information for management team [3] – The management team of a company can use directly the information available about the VoIP statistics to generate financial reports for the structure of communications costs;
- Online technical support [1, 8] – The company offers an online support based in Yahoo Messenger, Google Talk and Skype.

The NextStag intends to follow a strategy based simultaneously in leadership by differentiation and price. However, the company admits that the differentiation is the most important segment, even if for domestic market the price component increases its importance. Therefore, the strategy of the company can be changed according to the different markets (regional and domestic) that it is addressing. This approach can be done based in the modular architecture and flexibility of configuration of the VoIP solution.

Conclusion

NextStag is a VoIP telecom company located in India, which provides a high quality and cost-effective VoIP base telecommunications solutions. NextStag is specialized in providing high-level Asterisk support to customers with standard implementations and highly customized Asterisk solutions. The company operates essentially in the domestic and regional market of Asia.

The company bouquet of products and services includes VoIP communications solutions, billing systems, softphones and Asterisk consultancy. The NextStag IP PBX is a flexible featured IP-PBX. NextStag Calling Card offers lower cost international calling solutions. Softswitch is an API that is used to bridge a link between PSTN and VoIP networks. NextStag CallBack implements a callback service for VoIP businesses. NextStag CallShop provides a feature rich platform for outbound calls to call-shop owners. NextStag Sofphone offers a typical softphone solution. SIP Express Router allows the system to handle with a big number of calls simultaneously. Finally, NextStag Asterisk Services provides customization and configuration of Asterisk-based solutions and implements the IVR technology.

The NextStag has a deep knowledge of the Asterisk platform. The solution offered by the company is modular and contains a high level of components. Due to its modular architecture, it is easy to add new features and include it in a new module or in current one version.

The use of SER gives to the solution provided by NextStag the ability to deal with a high number of calls simultaneously. The use of SER gives the possibility to use a high-performance and configurable SIP server. SER is considered a very capable SIP router, much more sophisticated than Asterisk, because it can look inside packets and route based on what it finds or even re-write packets based on user specific logic.

The NextStag intends to follow a strategy based simultaneously in leadership by differentiation and prices. This strategy can be adapted according to the market that they are addressing, where the company gives more importance to the price component in the domestic market.

More information about NextStag and some documentation provided by the company can be found in annex J.

6.5.4 Bicom Systems

Short Overview of Company

Bicom Systems was one of the first companies in the world to deliver Open Source communications software as a professional turnkey solution. The company has now three branch offices located in USA (California), England and France.

The company's founders, Senad Jordanovic and Stephen Wingfield, had previously run a company specializing in content management (CMS) and customer relationship management (CRM) applications. "We saw an opportunity to create high grade commercial solutions by combining these applications with Asterisk", said Bicom President Wingfield. "Asterisk had by far the best portfolio of functionality and promised to continue its development because of this Open Source nature" (Schuk, 2005).

By combining the best of Open Source telephony and its own proprietary software, Bicom Systems can provide enterprises with turnkey solutions that take account of the clients' exact needs within a very cost-effective framework, giving to the CIOs a safest choice. This mix includes royalty-free software, vibrant Open Source communities, available custom development backed up by accountable and professional support services.

The company tries to find innovative Open Source communications projects and professionalizes the project by creating, unifying and supporting turnkey systems with its proprietary in-house software. Bicom Systems provides the resources, core development and support services to enable popular Open Source projects to scale into enterprise-class communications software.

Open Source Solutions and Services

Bicom Systems has a wide range of products and services available. Looking to the services, it provides the following:

- PBXware installation and configuration – it includes, system staging, onsite system installation, remote system configuration and system testing;
- Tech support – with the possibility of choice between a standard tech support, enhanced tech support and premium tech support;
- Maintenance contracts – with the possibility to have a remote or onsite system maintenance contract;
- Professional services – in the field of system diagnostics, consulting and development;
- Training – remotely or on-site.

Looking to the products, the company provides the following solutions:

- PBXware;
- OutCALL;
- WebPhones;
- SERVERware.

PBXware

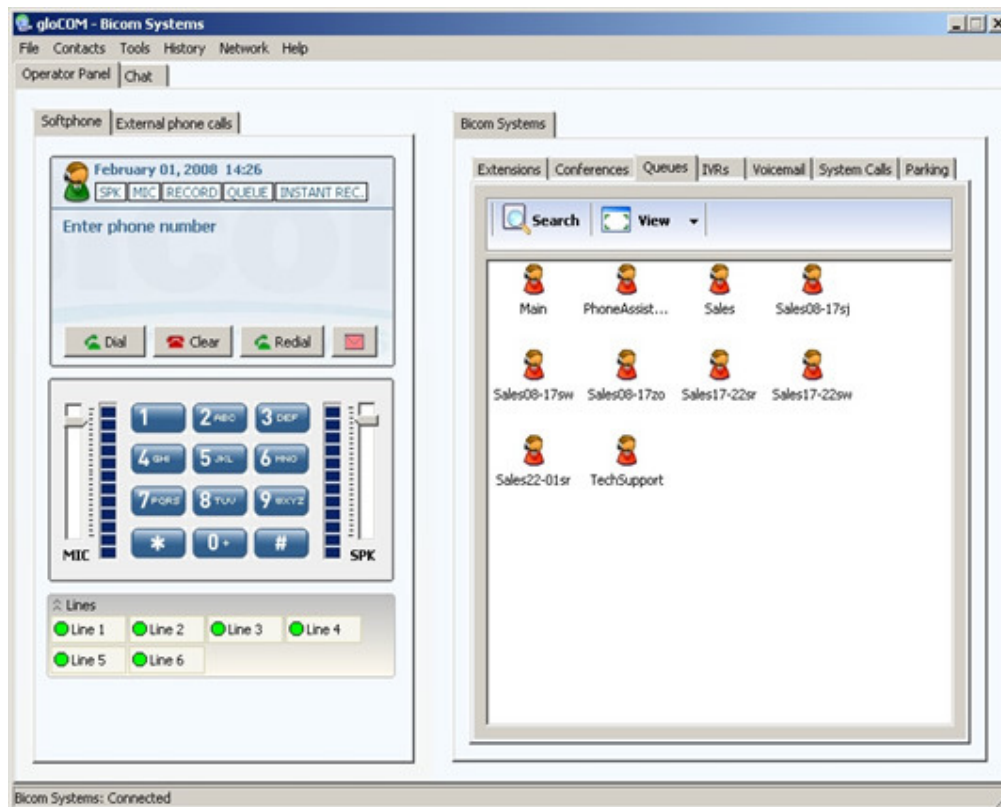
PBXware is a scalable PBX solution featuring a range of traditional telephony and emerging VoIP technologies. The creation of national/global voice networks and a full range of PSTN and VoIP technologies are supported.

PBXware is delivered in CD, tarball, appliance or VPS formats each supporting an easy to use Setup Wizard allowing setup of a fully functional PBX in minutes. Administration is performed through included Web Interface or CLI.

PBXware offers flexibility, performance, delivery methods, easy to use yet extremely advanced features not found at the majority competitors' offerings. Auto updates, system backup, provider templates, call recordings, real time call monitoring are just some of advanced features included in this solution.

Here, we show two of the most important scenarios of this application: configuration windows and end user applications.

Figure 52: Most important scenarios of PBXware application



Source: Bicom Systems, 2007

To facilitate the application's configuration, a step by step system wizard was developed. All necessary system functions are covered in order to allow minimum setup time. It has been designed to allow anyone with common knowledge to enter required information after which the system will be setup for normal operation.

In the end-user application layer, it was developed a new solution called OPCOM. It is a MS Windows based application fully integrated with PBXware product, allowing an operator to manage incoming and system calls.

OutCALL

OutCALL application is designed for integration with MS Outlook giving users powerful tools at hand for placing and receiving calls. OutCALL features are:

- Integration with one or unlimited extensions (SIP/IAX);
- Automatic operation with Microsoft Outlook 2000 and higher;
- Call history;
- Real time call notification via pop-up windows;
- Placing calls within Outlook, email message or contact;
- Automatic contacts data update;

- Automatic application updates notifications;
- Full PBXware/SWITCHware integration.

The OutCALL solution is available in two license models: Open Source and Branded. An Open Source OutCALL is available at SourceForge and a Branded OutCALL allows resellers, OEMs and system integrators to offer OutCALL to their clients.

WebPhones

Bicom provides a package of web-phones that allows the use of a computer as a virtual telephone. With a web-phone, it is possible to make and receive calls right from the user PC, including: computer-to-computer, computer-to-wireless and computer-to-regular telephone calls. The user will also get a phone number, so people can call the user, regardless of whether they are on their computer, on a cell phone or using a traditional phone connected to the PSTN.

SERVERware

SERVERware is a solution designed for service providers wishing to offer hosted services like PBXs, soft switches and complete Telco-in-a-box offerings. It has been built with redundancy, scalability, flexibility and very high availability from start up.

SERVERware is available in two editions: Server and Network. The Server edition is a very economical service to a company which starts its own hosted services. The company will only need one server with the following specs: Dual Xeon/Opteron, 2Gb RAM and 250GB RAID1/RAID5 storage. The Network edition allows a company to start a very high availability hosted service using four servers. Besides that, this network can be easily expanded.

In figure 53, we show a small preview of the application:

Figure 53: Overview of SERVERware tool


Name	IP	Status	Uptime	Context	Processes	Host
switchware	87.238.74.91	running	13 days, 21:53	1296	58	87.238.74.71
callware-1.9-two	87.238.74.84	running	12 days, 23:45	1255	45	87.238.74.71
telcoware	87.238.74.90	running	13 days, 21:53	1268	58	87.238.74.71
copyt0	192.168.4.11	running	1 days, 05:57	10761	2	127.0.0.1
forums	87.238.74.103	running	9 days, 01:59	1273	27	87.238.74.71
ns2	87.238.74.102	running	13 days, 04:06	1271	3	87.238.74.71
site	87.238.74.104	running	3 days, 06:50	1259	13	87.238.74.71
a2	87.238.74.93	running	10 days, 00:25	1265	43	87.238.74.71
switch	87.238.74.81	running	13 days, 21:53	1258	62	87.238.74.71
pbxwaredemo	87.238.74.87	running	8 days, 06:24	1299	46	87.238.74.71
callware-1.9-one	87.238.74.83	running	12 days, 23:45	1256	57	87.238.74.71
lists	87.238.74.11	stopped	0	1253	0	87.238.74.71
gentoo-t	192.168.1.253	stopped	0	1297	0	127.0.0.1
phonecall	87.238.74.94	stopped	0	1261	0	87.238.74.71
ns1	87.238.74.103	stopped	0	1270	0	87.238.74.71
openvpn	87.238.74.46	stopped	0	1257	0	87.238.74.40
samir	87.238.74.99	stopped	0	2399	0	87.238.74.71
faruk	87.238.74.89	stopped	0	1289	0	87.238.74.71
fare	192.168.0.11	stopped	0	27247	0	127.0.0.1
proba	192.168.1.253	stopped	0	1256	0	87.238.74.40

Source: Bicom Systems, 2007

Attending to the figure 53, we realize that each application can be run in a different virtual private server (VPS). A VPS, also referred as Virtual Dedicated Server (VDS), is a method of partitioning physical server computer into multiple servers where each has the appearance and capabilities of running on its own dedicated machine. Each virtual server can run its own full-fledged operating system and each server can be independently rebooted.

Clients

Bicom Systems has some important clients in different activities fields. Bicom Systems developed some very successfully projects to the following companies:

- Lamont-Doherty Earth Observatory;
- PayLane;
- Ouagadougou Airport;
- Children First.

We will look with more attention to the last three projects.

PayLane project

PayLane is an online payment processing solution provider, targeting merchants worldwide. The company is in fast expansion of its business worldwide and needed to put in place a telephony base that would be reliable and flexible for the future on top of the existing office

infrastructure. Promoting a high-tech service that is responsible for customers' financial transactions meant the need to choose the most secure option.

PayLane had no shortage of in-house IT skills and hardware so there was a natural affinity to go software only and keep open possibilities of Computer Telephony Integration (CTI). For the initial deployment offices were in Poland where the legacy system was SIEMENS 5300. One was for the administration of the company and systems and to be housed in the parent company's office located in UK, Implix. The other was to be a Call Center located in Poland. Customers would be calling in from around the world and in particular from the UK & Ireland, outbound calls too would be made worldwide.

Importantly, as expansion took place, the Call Center would depend upon agents being able to reference data quickly and easily so CTI needed to be prepared for it. One critical issue though was that a company in which billion dollar customers trusted their financial transactions should have a phone system that was equally reliable as Paylane's own service.

Considering the critical importance, the solution was to prove remarkably simple. Rather to the contrary of advice provided by many other vendors.

For both offices a simple download from the Bicom Systems web site of PBXware was made, followed by running the set-up wizard. IVRs were clearly a priority and the PayLane team were confident with their internal resource that they could complete these without assistance. There was also the need to network the two offices and existing legacy PBX and to integrate with Microsoft Outlook but later to consider integrating with the company's own CRM. Again from seeing Bicom Systems copious documentation the software only route appeared to offer the best control and security for PayLane.

PayLane has now both offices up and running. Calls may come in from UK & Ireland at local rate and the company is able to portray an international presence that previously was possible for only the largest of multi-nationals.

Internally, more staff were added and integrated through a uniform dialling plan. The system is working so satisfactorily that they plan further expansion and integration with the company's own CRM. Individual agents activity and the group can easily be measured to determine average wait times for customers, numbers of calls answered, number of calls in queue at any one time and much more.

Most important of all, PayLane has the security of knowing they control the implementation and respond to any stress or demand should this be put upon them. For the critical nature of their business, no estimate of price could be given and yet all was achieved with a minimal cost.

Ouagadougou Airport project

Ouagadougou Airport is the international airport serving the capital and largest city in Burkina-Faso, West Africa. As with many cities in the region, it is in fact expansion. Last year, the airport traffic passed over 200.000 travellers and yet more in freight to and from all over the world.

International telephony traffic was a high priority to the airport and its customers. A variety of telephony systems were already in place both VoIP and traditional which needed to be integrated with 120 users access points, spanning four buildings.

Bicom Systems partner Ka-Technologies had only five days to complete the install before their return of flight to Paris. Hardware also needed to be sourced in a manner that local engineers could easily make reparation when a failure occurs. The installation also promised to offer a flagship example throughout the region, so failure was simply not an option and an efficient manner of redundancy would be needed. Besides that, many of the technologies in place were not possible to identify until the arrival of Ka's engineer.

The solution comprised four HP servers that were to be flown from Paris to Ouagadougou each with PBXware Business Edition preloaded. Three of the servers were to be satellites, each supporting 10-20 users, backed up to the main server, itself in RAID. All servers were to be networked to provide a uniform numbering plan and telephony local cards were added to the central office server to provide access to the T0. Existing traditional handsets were to be connected by a FXS gateway. At the same time, international trunks were configured to provide low cost access to overseas calls in a country where the incumbent provider still charges for international calls by the dollar not the cent.

As a result, all four locations are now networked with the existing handsets. International calls are costing a small percentage of previous amounts, and managers can take a full advantage of IP when they travel. There is considerably more unity to the airport's facilities but also with an interface in local language. They are now considering networking with other airports, with whom Ouagadougou has much telephony traffic.

Children First project

Children First Florida (CFF) is a non-profit organization in Florida, United States, whose goal is to provide private school, scholarships to low-income children who are struggling academically, socially or emotionally in their assigned public school. Thousands of Florida families apply for the scholarship every year, generating significant call volumes to the application processing center.

The organization had been an early adopter of hybrid IP/Traditional PBX to organize and supplement its ten POTS lines and provide IP capability. Their original hybrid IPPBX software was delivered on a Open Standards hardware. The previous system was intuitive in some respects, but its evolution towards VoIP was clearly not enough to keep up with what was becoming very real call volume requirements.

CFF had the basic infrastructure in place for their telephone system, including ten POTS lines, IP handsets from Linksys, Dell Open Source server with Digium analog ports and other standard elements. Given the non-profit status of the organization, there was the need to confine to a very limited budget. Therefore any reinvestments in hardware would not have been welcomed by CFF's Board of Directors. At the same time however, CFF was dedicated to serving the needs of Florida children and finding ways to meet objectives by expanding their communications capabilities.

There was the immediate need to organize CFF's internal lines to include even the most elementary requirements such as call forwarding, voicemail, on hold features and other basics. CFF was also experienced an excessive monthly expense for ten POTS lines from their local telecommunications provider.

The real challenge was to have IVR capabilities that would direct callers to various menus depending on their reasons for calling CFF. Different prompts needed to be designed to address the needs of renewal applicants, new applicants, families checking the status of applications and other types of calls. In addition to the above, CFF needed a way to dynamically track the language preferences of each application family as well as other application details such as missing documents, etc. To meet these requirements, CFF needed a system that enabled them to easily change message prompts and menus, as well as track responses to prompts. Furthermore, such frequent message customization requirements meant that the system needed to be maintainable by CFF's own staff.

As a solution, PBXware was easily integrated with CFF's server and supported the existing handsets. As such, there were only minimal software and support issues to consider. CFF's own internal engineer was confident from previous experience that this would install easily onto the existing hybrid fibre-coaxial standard hardware, scan the network for devices, and be up and running quickly. Bicom Systems tapped their worldwide experience and training by setting up CFF's IVR to dynamically use Spanish & English in both the custom prompts and the default prompts.

The PBXware had the greatest impact through the use of Computer Telephony Integration (CTI). Using this technology, CFF was able to create their own CRM to decide what messages would be heard by the caller. Through CFF's own database, it would now be easy to know what application documents were missing and the language preferences of each applicant, allowing CFF to respond accordingly with the most appropriate instructions.

In the year of 2007, CFF has been able to help 65% more children than last year without a significant increase in operational costs. Furthermore, in key areas such as postal service and telephony, there have seen cost reductions. Internally, CFF staff was able to organize their working routines better than before and schools and students can more easily navigate through the call system to find the resources they need to address their queries.

Competitive Advantages and Business Strategy

The major core competences of Bicom Systems are:

1. Partnership with hardware suppliers and vendor agents;
2. Deep knowledge of the VoIP technology and its value chain;
3. Deep knowledge of networking and security fields;
4. Integration of Open Source and commercial solutions;
5. Technical competences and available products in the fields of CSM and CRM solutions;
6. Dimension and structure of the company;
7. International background of technical and management team;
8. Competences in the financial management field;
9. Network contacts of company.

Based in these core competences, we can establish its competitive advantages, which can be supported in the following 5 levels:

- Brand reputation [1, 2, 6, 9] – The company has a solid reputation in the international market in the creation of robust VoIP solutions, especially for service providers that intends to offer PBXs solutions;
- Partnership network [1, 9] – The company has established partnerships with hardware suppliers that guarantees technologic advanced solutions. Besides that, the partnership with vendor agents and others resellers reduces the time for market of new products and add-ons;
- International focus [1, 6, 7] – Actually, the company operates in North of America and Europe. This international focus makes possible to the company to address distinct geographic markets, increase its reputation and increase the potential addressable market;
- Quality of solution in terms of security and reliability [2, 3, 4] – The SERVERware solution is a good example of a solution with a strong focus in redundancy, scalability and high availability;
- Technical support [3, 4] – The company offers a typical full service of support based in three levels: standard, enhanced and premium. Besides that, it also offers maintenance contracts with the possibility to have a remote or onsite system support.

The Bicom Systems follows a strategy based in leadership by differentiation operation in a worldwide international market. It operates and competes in the USA and Europe markets. The company addresses only the business market, however their solutions are typically used in smart-home environments.

Conclusion

Bicom Systems was one of the first companies in the world to deliver Open Source communications software as a professional turnkey solution. This company started only to

provide proprietary CMS and CMR applications when they saw a great opportunity to create a high grade commercial solution by combining these applications with Asterisk. This combination let the company to combine the best of Open Source telephony and its own proprietary software and conducted the company to provide turnkey solutions that take account of the client's exact needs with a low cost-effective framework. The company has actually 3 branch offices located in USA (California), England and France and has some important international clients in different activities fields.

The company offers 4 kinds of products. The PBXware is a scalable PBX solution featuring a range of traditional telephony and emerging VoIP technologies. OutCALL is an application designed for integration with MS Outlook giving users powerful tools at hand placing and receiving calls. WebPhones provides a package of web-phones that implements the concept of virtual telephone. Finally, SERVERware is a solution designed for service providers wishing to offer hosted services like PBXs, soft switches and a complete Telco-in-a-box package.

One of the most important and relevant competence of the company is its ability to integrate Open Source and commercial solutions, namely in the field of CSM and CRM technologies, where they already had in the market some successful solutions. Besides that, the company has a strong focus in the technical support component. The company offers a full service of support based in three different pre-defined levels, maintenance contracts and remote or onsite system support.

The dimension of the company and its technical backgrounds in terms of operation, but also inside the management team, gives a very powerful brand recognition and reputation. The company has actually a solid standing in the international market in the creation of robust VoIP solutions, especially for service providers that intends to offer PBXs solutions.

The Bicom Systems follows a strategy based in leadership by differentiation operating in a worldwide international market. The use of Open Source solutions by the company can be seen as a strategic positioning based in the technical potentiality of OS solutions.

More information about Bicom Systems and some documentation provided by the company can be found in annex K.

6.5.5 Critical Links

Short Overview of Company

Critical Links is an international venture backed networking company and provider of edgeBOX, a multi-function "Office-in-a-box" or Business gateway targeted at SMBs and Enterprise Branch Offices.

Critical Links was launched in 2006 as a spin-out from an established and successfully software engineering company, Critical Software, with a solid reputation for software reliability (CMM-3, ISO9000, ISO9001) and a renowned customer based on the telecom, aerospace and defence fields.

The company closed its Series A round of funding in August 2007 and is currently aggressively expanding its network of channel partners worldwide, while moving its headquarters to the United States.

Critical Links has channel partners distributing the edgeBOX product worldwide with a special emphasis on emerging markets and a growing customer base. The edgeBOX provides a full voice, data, and IT infrastructure for small and medium businesses that is easy to deploy and maintain. The edgeBOX range of products targets companies with up to 300 users and allows SMBs to focus on their core business while increasing productivity and convenience by using advanced services typical of large companies for a fraction of the cost.

According to Critical Links CEO João Carreira “new networking products and services increasingly rely on software features to deliver differentiation and remain competitive”. “Our edgeBOX platform is ideally suited to enable the quick development of converged business gateways targeted at the booming SMB and managed services market” (edageek.com, 2007).

edgeBOX has been identified as a key player in the emerging “business gateway” market by leading analyst house InStat and won the Best Broadband Appliance award at the World Broadband Forum in 2005. It was selected a finalist by IDG Communications Techworld for its 2006 “Small Business Product of the Year”. It was recently unveiled in several European markets, following successful launches in Portugal, Brazil, China, India, Chile, Singapore, Middle East and South Africa.

Open Source Solutions and Services

Critical Links actually has a portfolio of three products:

- edgeBOX;
- edgePACKs;
- iTEMS.

edgeBOX

edgeBOX is an office-in-a-box appliance that provides a complete voice, data and IT solution for SMEs and enterprise branch offices. It effectively replaces an average of 4-6 devices, dramatically simplifying deployment and management of communications and IT systems with significantly lower TCO than with multi-product deployments.

Located at the edge of the network, every edgeBOX appliance provides a comprehensive range of data, voice and security services that are managed through a single and easy-to-use web interface. The edgeBOX product includes the following features:

- Access Router – manages the traffic between a LAN, the Internet via ADSL, 3G or Ethernet and a DMZ (demilitarized zone). It also provides all basic network access services such as DHCP, NAT, DNS and VLANs;

- IP-PBX – provides all the telephony features a small business needs, including: sophisticated call conferences, packaging and forwarding, IVR, LCR, ACD, fallback to PSTN, etc. The full featured IP-PBX supports both VoIP and PSTN calls and is a solid unified messaging foundation for a company;
- WiFi – provides instant hassle-free Wireless LAN access to the customer's offices. Can operate with and embedded Access Point (AP) or as an AP Controller with several external APs spread through the network and authenticating users through edgeBOX;
- Security – secures the company's network against attacks or misuses. Comprises a Stateful Inspection Firewall, VPN for remote user access or site-to-site (IPSec), supports anti-spam, antivirus and content filtering;
- File Storage and Print – provides scalable storage capacity and redundant disks (RAID) for a company critical data and for connecting the office printer. Allows seamless sharing of MS Windows files, setting disk quotas and configuring automatic backup to a remote server or an external USB disk drive;
- NAC – Network Access Control allows a company to control how employees and visitors access the network. Access can be granted/denied per user, service, IP, time-of-day, source (VPN, LAN, Wireless);
- Collaboration – provides a full collaboration suite that may include email (POP, IMAP, Webmail), groupware (calendar, tasks, contacts) as well as specific productivity applications (edgePACKs) such as CMS and LMS;
- Quality of Service (QoS) – guarantees that you priority services have the bandwidth available when needed, e.g., for ensuring business quality calls using VoIP and lowers the priority of other traffic such as web downloads. Supports both Inbound and Outbound Quality of Service (QoS) and support for custom QoS pipes guaranteed with DiffServ;
- Management – provides a unique and easy to use Unified Management Interface which is web based and allows the configuration of all aspects of the system by non IT experts.

edgeBOX is a simple but secure package at an enterprise-level security. Data and applications accessible through edgeBOX, either via physical links or VPNs, are protected by enterprise-grade firewall software, guarding your network from suspicious data packets and denial of service attacks. Users can be forced to authenticate at the firewall level before accessing any services, and any activity running through edgeBOX is logged. Network dependability is also of paramount importance, no matter what is the size of the company's business. edgeBOX is built around a robust Linux kernel renowned for its stability and resilience.

edgeBOX allows for huge cost savings in the typical SMB both in terms of upfront purchase costs (Capex) and ongoing management costs (Opex). With edgeBOX, there are fewer products to purchase and maintain. The cost for maintaining is reduced due to the simplicity of the management interface. The IP voice system allows for the elimination of call costs

between offices and the overall reduction of outbound call costs. The edgeBOX is based on open standards and protects the SMB from expensive vendor lock-ins. Finally, edgeBOX is also a green product since the consolidation of several devices into one allows for significant energy costs savings.

edgePACKs

edgePACKs are optional plug-in modules for edgeBOX that add functionality for particular vertical markets or add a new set of features. They are fully integrated with edgeBOX and linked with functions such as Networks Access Control, security, web server and mail server.

edgePACKs are simple to deploy through the normal update service which can automatically install new modules as they are purchased. As with edgeBOX, they can be managed remotely without on-site intervention meaning no on-site know-how is required.

Currently the edgePACKs available are:

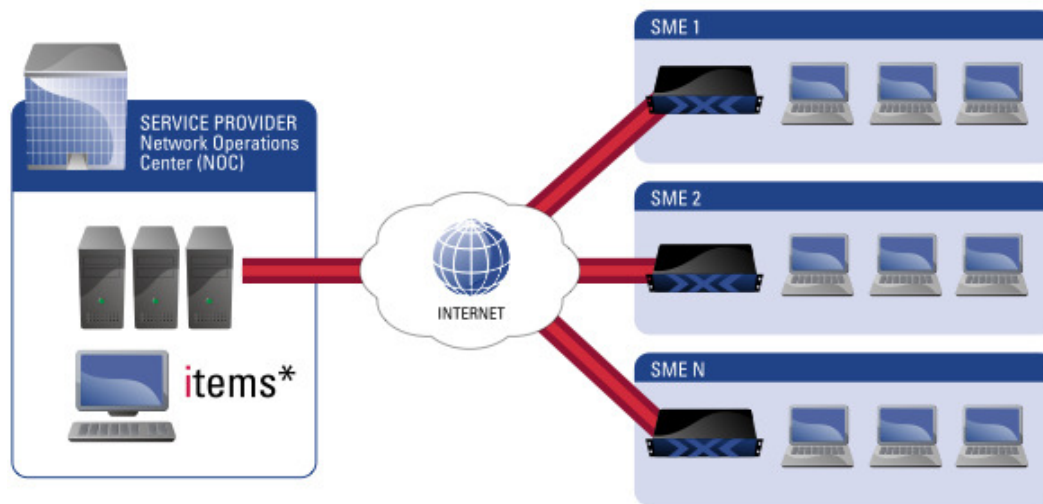
- edgeExchange – advanced groupware collaboration features;
- edgeCMS – providing website content management;
- edgeLMS – a learning management system for e-learning.

The use of edgePACKs simplifies application deployment and license management, dealing with the same partner for any edgePACKs related issues. Besides that it introduces significant cost savings (Capex and Opex) namely:

- Low upfront fees with optional support contract (1st year of support included for free);
- Installation savings, because edgePACKs installation takes substantially less time than alternative standalone products;
- Ongoing management and maintenance, troubleshooting and security breaches are all minimized;
- No additional servers required;
- Regularly updated with new features are added over the time.

iTEMS

Installed at the service providers Network Operations Centre (NOC), the iTEMS platform complements edgeBOX to provide an end-to-end solution that fulfils resellers and services providers' needs to deliver managed services to the SME market (see figure 54).

Figure 54: Architecture of iTEMS platform

Source: *edgebox.net*, 2007

iTEMS enables resellers and service providers to automate every phase of the business lifecycle, from mass subscriber device deployment and provisioning, to broadcasting software upgrades, proactive alarm management, subscriber tracking and inventory management, significantly reducing the time, effort and cost of deploying and management.

iTEMS has an intuitive GUI that allows network administrators to track subscribers, monitor activity, and apply changes anywhere in the network. For automating repetitive tasks, iTEMS also provides advanced scripting capabilities for a range of complex management actions. The administrator can, for example, program iTEMS to automatically download usage statistics files from each edgeBOX unit periodically (at a certain day/time) in order to better customize user configurations and to provide reports on network resource usage to customer's management staff. It can also schedule the upload of advertisements and information messages to deployed edgeBOX units at selected times.

Managed Service Providers offering value-added services such as VPN, WiFi and VoIP, can deploy and administer these services in an automated and controlled fashion and implement new business models that create additional revenue streams.

As the installed base of edgeBOX unit grows, the scalability of the management solution becomes critical, since the service provider must meet the needs of potentially hundreds of new customers being added daily. iTEMS supports more than 100,000 edgeBOX units from a single server and can scale further with multiple servers to meet future deployment demands.

iTEMS license pricing is also scalable since it is based on the number of edgeBOX units it supports. This mean the platform can be deployed with little start up cost, and license fees grow in line with additional revenue generated.

Clients

The major clients of Critical Links are the following:

- Portugal Telecom;
- ETronics;
- RGV Telecom;
- Altitude Software;
- Portucel Soporcel Group.

Critical Links addresses only the commercial market, especially the SMB sector. Actually, the most important and profitable markets are the Central Europe and USA.

We will look for two case studies to understand how the edgeBOX solution can benefit its clients.

Altitude Software project

Altitude Software is a leading independent contact centre vendor with the Altitude Unified Customer Interaction (Altitude uCI) product line. The Altitude uCI manages and improves customer relationships for each new interaction in a wide range of contact centres, from SMEs to large multi-site organizations.

The Altitude vBox v1.0, which was announced worldwide in 2005, is a turnkey solution that supports the full Altitude uCI multimedia contact centre functionality to running directly over IP networks in a reliable converged communications system. Highly scalable, the solution can start with just a few seats and grow to meet the specific business needs of each organization, especially those that have high geographical dispersion and need to share the same applications.

The Altitude vBox provides businesses with an open standard, software-based contact centre solution allowing for:

- Decentralized end-points with centralized management;
- Historical and real time reporting;
- Intelligent routing;
- Universal queue;
- Inbound, outbound and blended voice;
- Web collaboration and chat;
- Data look up and contact history.

The solution integrates an Open Source IP-PBX, a web-based configuration management interface, and an “Intel inside” fully integrated network appliance within a small, elegant robust box.

The edgeBOX is a complete converged voice and data networking solution that can also be customized to attend the customers' needs. In the case of Altitude Software, this entailed jointly developing Altitude vBox 1.0, based on edgeBOX pre-integrated with the Altitude uCI. This combination created an all-in-one contact centre solution that is simple and quick to deploy, easy to maintain and provides a wealth of features normally only found in much larger and more expensive systems.

The flexible and open architecture of edgeBOX enabled Critical Links and Altitude to work together to integrate the technologies of the two companies to provide a solution with the combined benefits of both. edgeBOX supplies a full range of voice and data services covering networking, security, Internet access and VoIP, providing a suitable platform for Altitude's uCI software suite.

The final product (Altitude vBox) enables contact centres to reduce costs by providing a solution that is simple to deploy and maintain, minimizes call charges by making use of the IP network and improves agent productivity. edgeBOX can route calls over ISDN phone networks or IP networks, provide Internet access and act as a mail transfer agent. The Altitude vBox 1.0 enables seamless integration of multiple communications channels within a given customer interaction. Brought together, these technologies enable contact centres to leverage the advantages of each communication medium to provide improved agent productivity.

For example, an interaction that begins with voice (PSTN or Internet) can add email or chat and all of the channels are seamlessly tracked and controlled within the Altitude IPCC environment, using Altitude's Universal Queue and Universal Router. The security services of edgeBOX, such as firewall, antivirus and VPN encryption, ensure that all voice and data traffic is adequately protected.

Portuguese Public Schools project

CRIE is a mission unit of the Ministry of Education created on the 1st July 2005. CRIE's mission is the conception, development and evaluation of initiatives concerned with the ICT infrastructure used at schools and in the learning process.

The project "Ligar Portugal" is one of the strategic pillars of the Portuguese Technological Plan, an ambitious government programme for growth and competitiveness based on the promotion and development of the Information Society. The project started by integrating all schools into the online network of research institutions and universities, strengthening the links between these institutions and facilitating information sharing amongst them.

The current goal of "Ligar Portugal" is to create a unified technology infrastructure network across all public schools. A technology upgrade is needed in 7000 schools by 2008 to put systems in place that will be flexible enough to grow with the individual needs of each institutions, at the same time as being structured and coherent enough to provide the required unified architecture. Most importantly, however, the system needs centralized management capabilities with low cost of ownership.

Ligar Portugal's daunting mission to roll-out such a large, standardized network became much simpler when they discovered edgeBOX from Critical Links. edgeBOX provided everything they required out of a single box including advanced security, collaboration, storage, built-in QoS, a feature rich IP-PBX and VoIP gateway. All the services are pre-configured and pre-integrated into just one device, delivering the low TCO required.

Remote management is achieved through a single web-based, user-friendly interface which controls all the features of edgeBOX and can be accessed on-site or remotely by a dedicated team in a central location. The management interface is complimented by the purpose built provisioning tool, called iTEMS. iTEMS is installed at the network operations centre and provides facilities for bulk configuration, real-time monitoring and alarm management of deployed units. This reduces installation time and enables FCCN (National Foundation for Scientific Computing - manager of RCTS, the R&D and education dedicated communications network) to fulfil the service level agreements they have in place with the institutions whose networks they are managing.

Additionally, the solution's dynamic and open architecture played a key role in edgeBOX's inclusion in the Ligar Portugal project. edgeBOX's ability to incorporate new technologies as they become available and as the demands of the education sector change, provides a future proof solution and protects the investment of FCCN.

Lastly, despite being a single box solution, edgeBOX is packed full of advanced networking technologies normally only found in much larger and more expensive systems, including an IP-PBX, VoIP gateway, WiFi access point, 3G broadband support and the latest security systems.

This solution provided important benefits for the Ministry of Education, namely in terms of:

- Constant communication – staff and students have access to their e-mail via a secure web application, so they can keep up with coursework while away from the school and the forum application hosts online message boards where students and staff can discuss courses, homework assignments, as well as life at the school;
- Personal organization – along with the webmail application, the solution integrates additional web-based applications that assists in organizing personal and school life, making edgeBOX pivotal for communication between people as well as computers;
- Content publishing – edgeBOX's content management systems make it easy to publish and manage all internal and external web pages, making them an ideal tool for online collaboration;
- Course Management – edgeBOX can be used as an application platform with fully integrated authentication and access control. This has been used to incorporate a Learning Management System into edgeBOX;
- Virtual Learning Environments (VLEs) – it supports the creation of effective VLEs providing blended learning opportunities for students;
- A plethora of possibilities – edgeBOX provides a wealth of possibilities in educational environments, including applications to improve internal and external

communications, better organize course work and collaborate in new and exciting ways.

Competitive Advantages and Business Strategy

Critical Links and especially Critical Software is one of the most successful Portuguese Company that operates in the international markets. The major core competences of Critical Links are:

1. Flexibility of modular approach of edgeBOX;
2. Deep knowledge of networking area and open-source software;
3. R&D internal team;
4. Development of independent vendor solutions;
5. High level of team qualifications;
6. Web graphic interface;
7. High level of available components;
8. Integration of functionalities;
9. Partnership with telecom operators;
10. Partnership with vendor agents;
11. Use and integration of open-source and commercial solutions;
12. Background and support of Critical Software;
13. Organization of company in terms of human resources and financial competences;
14. International background of technical and management team;
15. Evaluation and tests of source code;
16. Marketing component.

Based in these core competences, we can establish its competitive advantages, which can be supported in the following 10 levels:

- International focus [10, 12, 13, 14] – The target market of Critical is the global international market. For Critical Links the most attractive markets are Central Europe and USA. To address these markets, the Critical Links moved its headquarters to Fairfield in the metropolitan area of New Jersey and it has a delegation in Southampton (UK). Besides that, it has a representation in New Dehli (India);
- Brand reputation [2, 10, 12, 13, 16] – The background of Critical Software gives a very important reputation in Portuguese and international markets. Besides that, the presence in international big conferences and show rooms helps to divulge and increase the reputation of the solution;

- Quality of solution in terms of security and critical issues [2, 3, 4, 5, 12, 15] – This project started based in a network solution for critical mission of activities. This focus is still valid for the actual version of edgeBOX available in the market;
- Technical support [2, 5, 13] – Critical Links offers a support of 3-tier level: traditional helpdesk, technical support or remote intervention. Besides that, some of this support can also be provided by its resellers;
- All in-one type of solution [1, 2, 3, 4, 7, 8, 11] – All of these solutions are available in simple, easy to use and configure device. A company can use one single device to manage all the network of the company, instead of use traditional single one devices. With this kind of solution it is also possible to avoid typical compatibility issues;
- Simplified network administration [6, 8] – Using a single device and a single web interface, it is possible to configure a lot kind of services;
- Experience of technical team [2, 3, 5] – The team has very good technical supports and it is involved in R&D projects. At the same time, Critical Links recently developed its own formation plan;
- Partnership network [9, 10] – the business model of Critical Links is based in international partnership, which are responsible to collect information about the market, sell the product and give formation;
- International awards at conferences and Expo rooms [3, 10, 13, 14] – The quality of the final product is evaluated and certified by independent and recognized specialties in this field of IT. This facilitates the appearance of new interested vendor specialists and encourages final users to use its solution.

Critical Links follows a strategy based in leadership by differentiation operating in a worldwide international market. It intends to compete in very big and developed markets like USA and England, but it also focuses its attention to serve so different and high-grow markets like South Africa and India. The company addresses only the business market.

Conclusion

Critical Links is a spin-off company launched by Critical Software, a very recognized Portuguese company that operates in the field of mission-critical market segment. Critical Links company has an international approach and focus in the delivering of edgeBOX solution, a multi-function “office-in-a-box” for SMBs and Enterprise Branch Offices. The company has a channel partners distributing the edgeBOX product worldwide with a special emphasis on emerging markets and a growing customer base. Some of the major clients of Critical Links include Portugal Telecom, Altitude Software and Portucel Soporcel Group.

Critical Links actually has a portfolio of three products. edgeBOX is a multi-function network appliance that consolidates data, voice and IT services for small and medium size organizations. edgePACKs are optional plug-in modules (groupware, CMS and LMS) for edgeBOX, which are fully integrated with edgeBOX and linked with functions such as

Network Access Control, security, web server and mail server. Finally, the iTEMS platform complements edgeBOX to provide an end-to-end solution that fulfils resellers needs and let the service providers to deal with several edgeBOX devices.

Critical Links has a deep knowledge of networking area and open-source software due to its previous experience in the Critical Software. Besides that, the modular approach of edgeBOX turns possible to install very different devices version of the edgeBOX in different clients, taking in consideration their needs.

The partnership network of Critical Links includes the partnership with telecom operators and vendor agents. These two kind of partnership let the company to collect more precise information about the market, product sells and formation. Besides that, the strong focus in the quality of source code and certification gives a strong brand reputation. Besides that, the company has also a strong market component and works closely with their vendor agents.

The Critical Links follows a strategy based in leadership by differentiation and operates in a worldwide international business market. The company has a presence in international big and developed markets as USA and England, but also has partnerships with vendor agents and branch offices in high-grow markets like India and South Africa.

More information about Critical Links and some documentation provided by the company can be found in annex L.

6.5.6 iPortalMais

Short Overview of Company

iPortalMais develops and distributes knowledge through networking operating systems based on Linux, security solutions supported on Kaspersky Lab software and document management solutions, aiming a simplified and cheaper IT use in business and public organizations. Its main business is to sell their knowledge to their partners to make sure that they are able to enjoy all the Linux OS benefits with their customers, without the need of being Linux experts.

The company was born in May of 2000. It was an intense activity period for Linux in Oporto. Lots of events promoting Linux took place inside the Engineering Faculty of Oporto University (FEUP), but that year Linux jumped to the city streets with the sponsorship of the faculty and the city hall. The company starts with the thrust of these events, aiming different areas based on Linux, including the installation and configuration of Linux Servers.

With the IT crisis in 2001, this area becomes the focus of iPortalMais. With less money to spend, Linux solutions based on free software and services are more attractive to customers and service integrators.

In the middle of 2001, the company starts its first R&D efforts with the creation of an innovative approach to a Document Management solution. Document Management would be a network service based in a set of protocols widely used on Intranets. The Document Manager (iPortalDoc) was based in Linux.

The project took a very successful path. In the end of 2002 there were already several partnerships to sell iPortalDoc. Based in the success of this product, the R&D department added another product to iPortalMais portfolio. The product was named IPBrick.

iPortalMais internationalization process goes stronger with Kaspersky Lab relation. IPBrick integrates Kaspersky technology to the Linux servers with automatic installation. The first iPortalMais partners abroad are Kaspersky distributors. Kaspersky also led the company to participate in its first fair, COMTEC 2004, and it was an huge success. The company also participated in other fairs like SIMO 2005 – Madrid, Solutions Linux – Paris and Cebit – Hannover.

Open Source Solutions and Services

The iPortalMais company develops its activity in the following three areas:

- Intranet;
- Communications;
- Document Management.

We will take a brief overview about these solutions and products, considering particularly the IPBrick.GT solution.

IPBrick.IC

IPBrick is a complete integrated server system, which offers a low total cost of ownership (TCO). The installation of this platform can be done in just 10 minutes.

IPBricks.IC is hardware independent and in the case of hardware alternation (e.g. disaster issues or scalability needs) all enterprise and system specific adaptations are incorporated through restoration procedures. This task can even be simplified with the introducing of IPBrick.D (USB pen driver) for disaster recovery. Besides that, award winning Kaspersky security tools (anti-spam and antivirus) are truly integrated to minimize the risk of losing data integrity.

IPBrick contains the intranet and communication service model of any typical organization. It is easy to configure all the services without Linux or network knowledge keeping the advantages offered by Directory-Services (ADS and LDAP). Even specific configurations can be made using an advanced GUI for skilled people.

To summarize, these are the most important features of IPBrick.IC:

- IPBrick system information;
- Complete graphical representation of all system functions;
- Ease of configuration through web interface;
- Fast installation relying on its “BusinessLogic”;

- Disaster recovery process within 15 min;
- Procedural configuration, enabling network administration without in depth IT knowledge.

IPBrick.GT

IPBrick.GT completes the software solution IPBrick.IC with hardware designed for enabling optimized voice and data integration. IPBrick.GT meets the demands of needed integration between traditional telephony and new VoIP SIP phones and SIP providers. IPBrick.GT implements a full PSTN/VoIP gateway allowing the direct connection to PBX (ISDN E1/Bri and Analog Trunks), PSTN operator, LAN and Internet. The intelligent routing enables voice to flow either via VoIP or traditional ISDN and analog technologies. IPBrick integrates traffic shaping functionality that will prioritize all telephony connections. The numbers of active and parallel phone calls are only limited by the given capacity of the user connection bandwidth.

The appliance is preinstalled with IPBrick.IC and it offers the following features:

- VoIP Data communication based on standard Internet protocols (SIP, RTP);
- Secure delivery of VoIP data through user defined VPN-tunnels;
- Intelligent voice call negotiation to foreign VoIP-Servers, SIP Provider and to the traditional telephony network;
- Isolation of the ISDN/Analog linkage to your PBX;
- A migration path, incorporating user legacy ISDN/Analog phones and PBX towards VoIP technology;
- Highly available VoIP company site linking;
- Extensive QoS features with integrated bandwidth-management.

The delivered PBX functions are administrated through the graphic interface of IPBrick.GT, namely the assignment of the VoIP addresses and phone extensions to the dedicated terminal equipment. IPBrick offers the manipulation of dial numbers inside the activated dial-plan (inbound and outbound). Functionality incorporates queue management and very flexible routing policies.

For outbound Internet telephony, that means voice connections to participants outside of the LAN: data transport is either directly negotiated to the VoIP recipient, or deliverer to a public SIP provider. SIP providers offer VoIP gateway technology to handle the call to the traditional telephone endpoints (ISDN, PSTN, cellular radio). Inside the user LAN, IPBrick.GT acts as a default gateway and handles all incoming calls as needed.

This given telephony equipment forward their calls through the connected PBX. This PBX behaves transparently with IPBrick.GT enabling an intelligent routing decision which will either negotiate the calls to the traditional telephone networks (e.g., emergency calls fax) or via VoIP to the Internet.

The IPBrick.GT comes with IPBrick.KAV, which is a security application built to protect the enterprise in the four most important security areas on present days:

- E-mail Security;
- Web Access Security;
- Network Security;
- Intranet Security.

The IPBrick.KAV is a solution that puts together the best of two worlds in security terms: communication server and security software. This solution prevents workstations from connecting to the Internet directly, not allowing Trojan programs to establish tunnels with the exterior or open backdoors that allow the access to the company network from the exterior, eliminating all the problems caused by Trojans. In order to achieve this, the IPBrick makes use of a set of Proxy services.

The Kaspersky Security Software eliminates, on the perimeter protection assumed by the IPBrick.KAV, all the malware (trojans, worms, spyware, phishing, virus, etc) which intend to infect the computers in the internal network. Besides that, IPBrick.KAV adds a new security function, an Intranet auditor, which is able to verify and identify which workstations are infected and therefore capable of compromising the security of the Intranet.

Document Management

Document Management Systems assume an increasing roll in corporation's productivity. Thus, its selection should follow utility, functionality and economic efficiency criteria.

iPortalDoc integrates Document Management in a workflow system, increasing data quality and improving the work force accountability. The company's major R&D effort and the long experience in corporate environment resulted in a breakthrough efficiency gain.

Its full corporate network integration simplifies all the information capture process and its organization. iPortalDoc runs on normalized applications, e.g., Web browsers, graphical file manager and email client. This feature allows an effective use of limited computer resources and the controlled access inside (Intranet) and outside of the organization building (Internet). The user-friendly interface minimizes the training needs for this tool. The only thing users must know to work, with the application is their corporate organization, e.g., document classification, workflows as well as template and document production.

The iPortalDoc conception and development promotes high adaptation capacity to the application environment and reduced customers investment. This capacity in association with a wide range of features reaches all kinds of organizations, like hospitals, universities, local government, service companies, public administration, industry, among others.

Clients

The major clients of iPortalMais company are located in Portugal and operate in the fields of government, telecom and industry. Among them we have the following:

- Ministry of Economy;
- Ministry of Transports and Public Affairs;
- ONI Telecom;
- Novis;
- Mota Engil;
- Efacec;
- Fertágus;
- City Council of Gaia.

Competitive Advantages and Business Strategy

The major core competences of iPortalMais are:

1. Personalization of installed components;
2. Possible to install new external services over the solution;
3. R&D internal team;
4. High level of team qualifications;
5. Compilation of several Open Source solutions in a single device;
6. Interaction with iPortalDoc;
7. Integration with external Open Source solutions;
8. Partnership with telecom operators;
9. Partnership with vendor agents;
10. Deep knowledge of network technology for Linux;
11. Focus in security mechanisms;
12. Technical competence of work team;
13. “Fault-recover” mechanism.

Based in these core competences, we can establish its competitive advantages, which can be supported in the following 9 levels:

- International focus [9] – the existence of international agents gives to the company the possibility to deliver the product to international clients;

- Brand reputation [3, 5, 8, 9, 10, 11] – the presence on international markets and the overall of solution based in opens-source solution supports an excellent reputation on the market;
- Solution robustness [5, 10, 11, 12, 13] – using open-source technologies, which have its source code opened, give the possibility to be tested by a lot of people al over the world. These solutions are more fault tolerant than closed-source solutions;
- Technical support [4, 9, 12, 13] – the company offers a support of 3 levels and the option to have the support directly provided by the vendor agents;
- Solution scalability [1, 2] – add of new communication services can be done directly by the client. The client can interact directly with the system adding new services and configuring them;
- All-in-one type of solution [1, 5, 10, 11] – all these communications services are available in a single solution that can be licensed per server;
- Simplified network administration of a Linux system [1, 2] – usually, configuration of a Linux system isn't an easy task, but with the IPBrick solution it is possible to do it using a friendly-interface oriented to the services of a company;
- Partnership network [8, 9] – the partners of IPBrick are responsible to implement and sell the solution directly to the client. Besides that, the solution can be configured by any VoIP operator;
- Unified communications over IP [5, 7] – the IPBrick doesn't offer only VoIP communications, but an unified communications platform. Using standard protocols is possible to integrate several solutions as voice, e-mail, fax, instant messaging, webchat and webphone.

The iPortalMais follows a strategy based in leadership by differentiation operating in a worldwide international market. However, the intention of iPortalMais is to develop the Portuguese market and have a strong internal presence, attending the international markets in some concise markets. At the same time, the component price will have a stronger impact, as soon the company starts to address the residential market.

Conclusion

iPortalMais is a company located in the city of Oporto that offers knowledge and professional technological solutions in the fields of network and data management systems based in Linux OS. Its main business is to sell their knowledge to their partners to make sure that they are able to enjoy all the Linux OS benefits with their customers, without the need of being Linux experts. The company has several important clients, namely the Ministry of Economy, Ministry of Transports and Public Affairs, Novis Telecom and Efacec.

The company offers three kind of products in the domains of Intranet, communications and document management. IPBrick.IC is a complete integrated server system based in Linux OS, which turns possible to offer a competitive solution with lower TCO. IPBrick.GT completes

the software solution IPBrick.IC with hardware designed for enabling optimized voice and data integration. Lastly, the document management solution provided by iPortalMais helps a company to track and store electronic documents.

The solution offered by iPortalMais is a compilation of several Open Source solutions in a single device. The intention of IPBrick is to provide an unified communications platform over IP networks and using open standards. The use of open standards turns possible to the company to integrate several solutions as VoIP, collaboration tools, instant messaging applications, e-mail and fax. Besides that, the unified communications platform increases business solution functionality, increasing the number of available communication channels, with clients, suppliers, collaborators, partners, etc. This platform can be integrated in environments, such as CMS, CRM, ERP, Document management and workflow.

Another important source of the competitive advantage of the company is the deep knowledge of network technology for Linux with a high focus in security mechanisms. Besides that, the “fault-recover” mechanism implemented by iPortalMais let the company to quickly check and fix the configuration of IPBrick solution at client offices.

The iPortalMais follows a strategy based in leadership by differentiation operation in the worldwide market, even if actually the company is essentially present in the Portuguese market.

More information about iPortalMais and some documentation provided by the company can be found in annex M.

6.5.7 VOIP@FEUP

Short Overview of Company

The Faculty of Engineering of University of Porto (FEUP) has started a project to slowly migrate its traditional telephony system to VoIP. The VoIP@FEUP (or PolySpeak, the commercial designation of the project) was initiated in 2005, by the Informatics Center of Engineering Faculty (CICA), and started to analyze several commercial solutions that could have been implemented at FEUP. After an exhausted analysis of these solutions, the faculty reached a decision that they had potential, but the price was uncomfortable for the institution. Therefore, the faculty initiated a search in the Open Source world to find another solution. Like in the other case, several solutions were analyzed and tested.

The result of the last process was the decision to build an internal solution with a similar performance and amount of functionalities available in other commercial solutions previously analyzed. Currently, it's perfectly possible to talk from a phone integrated in the old system call center to a new equipment in the new central without the need to use an external VoIP operator. On June of 2006 the university had already migrated over 400 users using hardphones and softphones.

In an interview, the project leader João Carvalho says that “people often fear to take the first step into the unknown”, but actually VoIP is no longer unknown. He also agrees that VoIP

has proven to be a reliable means of communication that is slowly taking over the market. One of the major advantage of using such a system is the saving of money: not only the calls are cheaper, but the expensive maintenance costs of old systems are things from the past. Further, it is possible to configure Internet trunks that permit two VoIP PBXs to communicate at zero cost without limits independently from the geographic location.

In September of 2007, FEUP released the new IP telephony with a new name called PolySpeak. This new system is based on the VoIP@FEUP and it includes some new useful features that will be analyzed in the following section.

Open Source Solutions and Services

In this section we will analyze the most important characteristics and features available at the PolySpeak solution.

The most important features implemented by PolySpeak are:

- Audio and video conferences;
- Voice mail integrated with e-mail;
- Integration with mobile phones;
- Control of costs per call;
- Plafond per user;
- Visualization of call costs per user and department;
- SIP/ENUM calls;
- Automatic selection of the cheapest route.

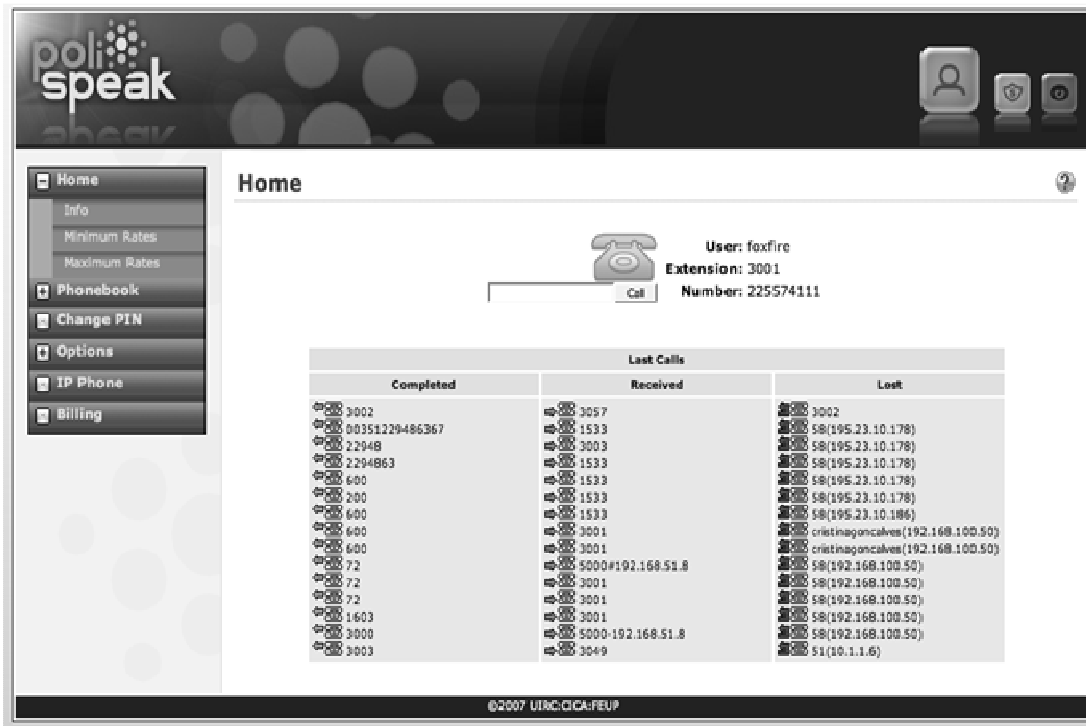
The whole PolySpeak system can be controlled through a user-friendly web-interface. Real-time statistics are useful to determine the needs and negotiate contracts with telecom providers. They also permit the end user to control their budget in a soft or hard way. The end user interface permits more than just viewing information. A “click and dial” feature has been interconnected with the address book and even the hardphone can be configured through it.

João Carvalho admits that this is a vital point for the end user. It argues that “it is very important to make things easy for the end user. Asking them to configure their own hardphone is out of the question, even if it is an easy task using the phones web interface” (Carvalho, 2007). Therefore, they created the necessary technology to do things automatically. When the user changes his PIN in the PolySpeak web interface, the system searches its internal database to discover which type of phone the user uses; if it is one of the supported, the system will change automatically the phones account setting and reboot the phone. This feature is available for Cisco, Grandstream and Polycom phones, but more can be added if necessary.

Other automated features, like the synchronizing of the private server's address book with the phones address book are also available. The user can also change certain configurations like language, appearance and ringtone directly in the PolySpeak web interface.

All configurations can be done via a web interface, from simply creating a user to more complex operation of creating trunks. But the web interface is not only for the system administrator, it has three different access levels: user, super-user and administrator

Figure 55: The user web interface of PolySpeak



Source:Carvalho, 2007

In figure 55 we can see in the upper right corner three icons, which allow the move from user option to administrator options. These three icons are only visible to the administrator user, two of them to the super-user and only one to end-user. The “super-user” level gives access to all server statistics in the accounting area and some partial information of the server. It allows the user to detect problems and report them to the administrators, but he cannot act on them. Normally, super-users are department secretaries who need access to detailed call logs for accounting purpose. VoIP servers do not normally let the end-user access the server, nevertheless the technical team found that giving users access to some features like “click and dial” or call logs will increase the usage of the system. The super-user can view almost everything, but cannot change any kind of configuration. Configurations like enabling accounting have to be performed in the “administrator” web interface.

One of the most used features by the users is the call box. It is very hard to write a name or email address on a hardphone, therefore this box is frequently used by people who have those kind of phones. A softphone normally permits entering addresses directly, but even these users prefer clicking on an icon rather than having to write the entire address by hand. Due to

the address book export feature via XML, the private list is a very requested feature. It is a safe way to keep the most important telephone numbers accessible wherever they may be.

Another very interesting feature is the voice mail. This feature gains a new dimension with the integration with the email. Any message that arrives to the user's voice mail will arrive at the same time to his e-mail inbox.

The solution developed by FEUP doesn't predict how much the phone call will cost. Because the server uses an LCR algorithm, it will try to pass the call to the cheapest route, but in case the connection couldn't be established it will try to use the next alternative route. Therefore we can see "Minimum rates" and "Maximum rates" in the "Home" tab. The advantage of this approach is the call will always be established, it doesn't matter if it uses the Internet or ISDN or whatever method was configured. If the user uses a supported hardphone it is possible for him to view these rates in real-time as the server tries to connect the call and hang-up before the call is established, if he does not agree with the price.

Some of the features were added by suggestion of the users. One of those suggestions was the ability to define a whitelist and a blacklist, which allow users to control who is allowed to phone them. A small add-on to this feature is the ability to redirect the call to another user instead of giving the caller simply a busy signal. This is very useful when using queues in a helpdesk and a caller does not want to respect the order of arrival.

One of the last features that was implemented is the ability to control users credit. The user needs to have a positive credit in order to make a call. Also the credit has to be enough to call the destination for at least two minutes. Once the call has started, it is limited to the maximum time the current credit allows. One minute before the credit expires, a warning message is send to the caller, warning that he has one minute of conversation left. The call is ended after the minute has passed and the user is unable to make new calls until his credit is restored. This feature is not to be used by staff, but will be used for the student server.

Only calls leaving the server through an actual provider are charged. The VoIP system was interconnected with most of the institutions that FEUP establishes regular voice communications. Like this way, all these kind of voice communications will be considered "internal calls" and will be billed as free calls.

Provider contract are negotiated based on the statistics found in this part of the interface. While the numbers of country calls are still dominant, one has to consider that these calls are usually short, therefore, negotiating a contract with an activation rate is not a good option. The same does not apply to international calls. These kind of calls normally last over ten minutes, thus negotiating an activation rate for a lower rate per minute is not such a bad idea.

Mobility is in our days another important feature of VoIP systems. Be at the user desk, at his home or miles away in a foreign country is the same, provided of course that there is an Internet connection available. The VoIP extension of the user is the same independently of his physical location. For example, one FEUP's user in a foreign country using a terminal equipment (e.g., a laptop), and with an Internet connection, can establish a VPN connection to FEUP and, after this step, register his extension in the VoIP server. At this moment, it will

be possible to receive and make internal or external phone calls exactly like if he was in his office, without the interlocutor perceive his geographic location.

Because PolySpeak is based on certified standards opposed to other commercial solutions, all SIP compatible hardphones will work, so it is possible to choose from high cost brands such as Cisco and Polycom to low cost brands like Grandstream. The choice of a hardphone is not as easy as it seems, because some phones will not support features like VLAN tagging in a correct way. This feature is very important for QoS without having to duplicate the network infrastructure.

Finally, another important point is the notion of quality. Relating to this question, the project has still some open issues like:

1. Which calls need absolute quality and which calls don't consider quality an issue?
2. How much more the user is prepared to pay additionally for better quality?

The PolySpeak solution lets the user define the quality of service for each phone call, independently of the destination. At this moment, it is possible to define it, respectively as low, normal and high.

Now, we present the features available for the administrator user in figure 56.

Figure 56: The administrator web interface of PolySpeak



Source:Carvalho, 2007

The administrator user can perform all configuration and maintenance here. Creating backups, updating the server with the latest revision is simple and straightforward. The

“system” tab permits to discover and configure hardware boards such as ISDN BRI and ISDN PRI. The “broker” tab allows to define dynamic brokers that are analyzed each 30 minutes for the best routes and availability. Creating users is simple, but when creating mass users, the best option is to use SOAP service, which enables the use of scripts. Trunks permit the interconnection of local PBX or VoIP servers. There is also the notion of Powertrunks, which permits two servers to synchronize their users as if they were one.

Instead of enabling access to all configuration option, the developer team have decided to make the interface as user-friendly as possible. Therefore, the interface tries to automatically configure a lot of features by itself simplifying the configuration process. A simple example of this is the division of SIP accounts into user, trunk, power-trunk and broker. Each of these accounts have specific functions and need specific configurations. The most interesting of them is the broker account. The server, in these cases, can obtain dynamically the current credit and current rates. All the information is used by the LCR algorithm in calculating the best route. Trunks and direct routing can be used to overwrite the LCR configuration.

Configurations such as Voicemail integrated with email work out of the box. Features such as Callback, Queues and IVR require a minimum amount of configuration due to the delicate nature of the functions they provide. Queues can be configured to act differently depending the time of day and day of week.

Clients

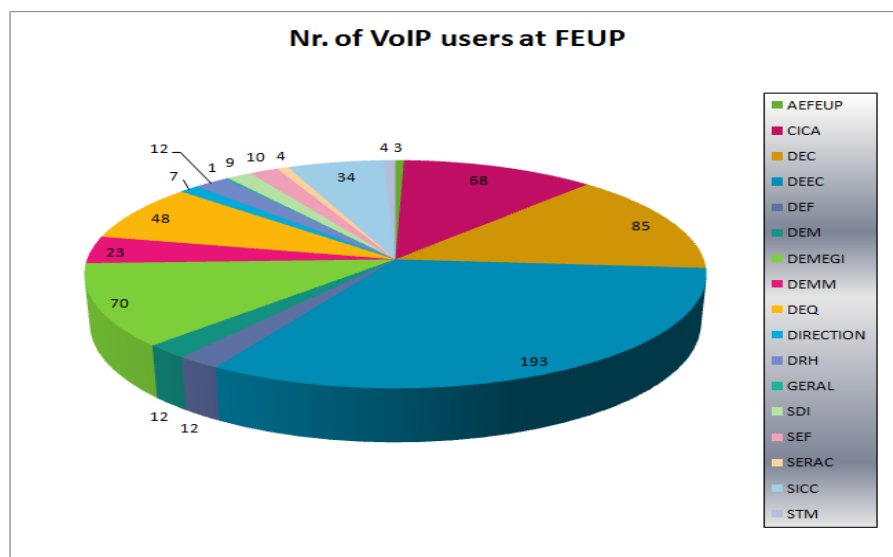
We can consider two kinds of clients of the Polyspeak solution:

- Internal users at FEUP;
- External companies, which have installed the Polyspeak.

At FEUP, the Polyspeak solution is being used by 588 users and it has installed 289 VoIP telephones. Initially, the users that adopted this solution, started to use software installed in PCs (softphone) and to communicate using headset or microphones and columns. Afterwards, the FEUP acquired IP phones due to the more valuable features like multiple lines, loud voice and quality of communication. Currently, the FEUP, after have resolved some problems to configure hardphones due to differences in the implementation of SIP protocol, supports two type of hardphone brands: Grandstream and Polycom.

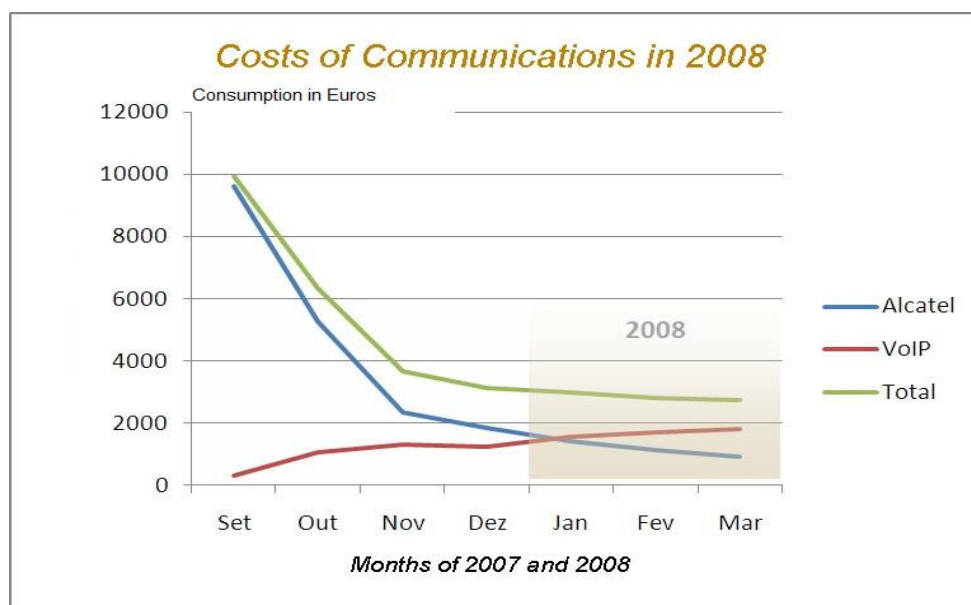
The Polyspeak was widely adopted by all FEUP community and recently was extended to all students of FEUP. Each user can manage his VoIP account of phone calls and transfer budget from the printer account to the VoIP account.

On February of 2008, the number of VoIP users per department at FEUP was as shown in figure 57.

Figure 57: Number of VoIP users at FEUP

Source: Pereira, 2008

The actual costs of voice communications at FEUP are represented in figure 58.

Figure 58: Cost of communications at FEUP in 2008

Source: Carvalho, 2008

In figure 58, we considered two source of communications costs, based in the operation of two PBX servers: Alcatel and VoIP. The Alcatel server is a traditional PBX, which is responsible to establish the calls between the university and external users using the PSTN lines. On the other hand, the VoIP server is the new server, which is responsible to establish the VoIP calls.

The costs of Alcatel calls have been decreasing due to the adoption of VoIP. At the same time, the numbers of VoIP calls have been increasing. However, the total costs of

communications are very lower than the previous, registered on September of 2008. The totals of costs of voice calls at FEUP were reduced about 70% in just six months.

Looking to the external clients, the Polyspeak is being used by the following companies:

- Casa da Música;
- CCDR-N;
- Faculty of Nutrition.

The CICA was already contacted by other private companies, which want to adopt the Polyspeak solution, especially by companies in the sector of education and private banking.

On April of 2008, FEUP conceded to Suprides a non-exclusive license of the PolySpeak system. This contract is automatically renewed each year and the amount of money received by FEUP depends on the number of users of PolySpeak.

Competitive Advantages and Business Strategy

Attending to PolySpeak solution provided by CICA department at FEUP, it was considered the following core competences:

1. Customizable solution;
2. Deep knowledge in the field of networking and Voice over IP;
3. R&D internal team;
4. Developing of a software independently of the user operating system;
5. High level of team qualifications;
6. Optimized developed solution;
7. Product scalability;
8. Use of innovative technologies;
9. Web graphic interface.

Based in these core competences, we can extract its competitive advantages, which can be supported in the following 8 levels:

- Performance and high level of functionalities [2, 4, 6, 8] – The Polyspeak contains a wide range of features that can be installed in the client. It contains some advanced solutions, like control of costs per call or automatic selection of the cheapest route, which can only be found in other international commercial solutions and some innovative solutions, like call box system, which were implemented based in the feedback of the CICA team. This feedback doesn't comes only by the developer team of Polyspeak, but also from other members that work at CICA in the networking and information systems sections;

- Simplified administration of VoIP network [1, 9] – The system contains 3 level of access of information: normal user, admin user and super-user. Each level can access different kinds of information providing useful information for the administration of the departments and networks;
- Reduced the need of intervention and human errors [6, 9] – The network administrator can configure all the phones using the web interface. Based in this web interface, he can also know all the characteristics of the phone that are being used by the user. In the case of any error, he can easily reset the configuration of the VoIP phone with the default configuration;
- Easily customizable [1] – The PolySpeak was developed based in a modular architecture. It is very easy to define the modules that we want to use in a different institution attending to its specific requirements;
- Solution scalability [1, 7] – The client can define the number of features that wants to use and, after some time, can modify this configuration and easily add new features. It won't be necessary to install and configure all the system again, only the new modules that the client requires;
- Experience of the technical team [2, 3, 5] – The team responsible for the developing of PolySpeak solution is an expert in the field of networking and VoIP. All of their members have an university or a master degree and participate in international conferences and publishes scientific papers in this domain. Recently, one of the team was invited to present this solution in the TERENA Networking Conference of 2007 at Denmark. Besides that, the CICA department, as member of FEUP, provides a work environment that promotes the R&D.
- Use of innovative solutions [2, 3, 5, 8] – The CICA is proud to use the most recent technologies in the field of VoIP and the department is always looking for the most recent improvements in this domain;
- Integration with SIGARRA intranet [1, 3, 7, 9, 10] – The functionalities provided by PolySpeak are accessed through a web browser and totally integrated in the SIGARRA intranet, which is being used by all FEUP and Oporto University community;
- Low learning curve [1, 9] – The client can start to use in a first instance just some of the most important features. He doesn't need to buy all the package and he can opt for a not so advanced featured solution that can take into account the time that the users need to use the product reliably. The learning curve of this solution is also reduced due to the excellence of the web interface and the interconnection between the hardphones, softphones and the administration interface.

The CICA division with the PolySpeak solution tries to follow a strategy based in the leadership by differentiation. The intention of the CICA is to provide this solution not only in the academic segment, but also in other commercial companies that operate in the field of culture, insurance and banks. It intends to follow a global approach and not only be limited to

a geographic segment. Besides that, like in all VoIP solutions, it intends to decrease the costs of phone calls to their clients. However, there isn't a consistent approach to minimize these costs taking into account other companies and VoIP operators.

Conclusion

The Faculty of Engineering of University of Porto in 2005 initiated a project to slowly migrate its traditional telephony system to VoIP. The Faculty conducted a search in the Open Source market to find a VoIP solution based in OS solutions and decided to build an internal solution based in the Asterisk platform, similar to other available commercial solutions. Actually, the PolySpeak solution is being used by 588 users and it has installed 289 VoIP telephones. Besides that, the PolySpeak is also being used by other external companies like Casa da Música, CCDDR-N and Faculty of Nutrition.

The PolySpeak implements some traditional solutions that can be found in other commercial solutions like audio and video conference, and voice mail integrated with e-mail. However, the PolySpeak offers some unique features as the control of costs per call, plafond per user and selection of cheapest route based in quality levels.

The PolySpeak is developed by a high level of qualified team and has strong interests and competences in the R&D field, which turns possible to provide a solution that contains a wide range of features and it is integrated with the SIGARRA intranet. At the same time, the application offers a simplified administration of the VoIP network. The system offers three levels of access for the information and each of these levels is suitable for the different users at FEUP, namely for administration of departments and networks.

The CICA division with the PolySpeak solution tries to follow a strategy based in leadership by differentiation. Initially, the intention of CICA was only to develop an internal solution that faces its internal requirements, but the PolySpeak is already being used by other external entities. Since 2008, CICA associated with Suprides to provide this solution to the international and national markets.

More information about the VoIP@FEUP project and some documentation provided by FEUP can be found in annex N.

6.6 Comparison of Solutions

In this section we intend to make a brief overview of the kind of solutions offered by companies analyzed in the case studies. To easily understand their similarities and differences, we categorized each company in the following four groups:

- Group I – Companies that provide VoIP solutions and are simultaneously VoIP operators. In this group we include Netcall and VipVoz companies;
- Group II – Companies that provide VoIP solutions based in the Asterisk platform. In this group we include NextStag and Bicom Systems companies;

- Group III – Companies that offer unified communications solutions. In this group we include Critical Links and iPortalMais companies;
- Group IV – Projects of VoIP solutions developed by universities or R&D centers. In this group we include the PolySpeak project developed in CICA department at FEUP.

The companies in group I offer a VoIP solution based in proprietary or Open Source technologies. Netcall customizes a solution for their clients based in a proprietary and well-established solution; instead VipVoz uses only Open Source solutions such as OpenSER, MySQL and SIP. These companies also complement their services offering hosting and e-mail services, firewall protection and VPN access. They are especially interesting to target the business market and they do not aim to compete in a price basis against popular solutions offered by Skype or VoIPBuster.

The companies in group II provide VoIP solutions based exclusively in the Asterisk platform. They have deep knowledge of Asterisk and they have experience to build highly customized solutions. Typically, their solutions are modular and contain a high level of components. Besides that, they usually provide a package of web-phones to implement the concept of virtual telephone, which allows the users to make phone calls using directly their PCs. In the case of Bicom System, the company combines Open Source and proprietary solutions and they integrate the phone system with CMS and CMR applications.

The companies in group III offer a complete unified communications device, composed by various integrated components, including messaging (email, IM, voice, audio), calling, conferencing, presence and mobility. These elements are all tied in together with the user's desktop or device, providing a consistent user experience. They don't pre-establish the VoIP operator and the user is responsible to define the VoIP operator for its national and international calls. In a first glance, the IPBrick.IC provided by iPortalMais and the edgeBOX provided by Critical Links seem competitors. However, this is not true in the majority of situations, because edgeBOX is a more complete and closed source solution than IPBrick.IC. The edgeBOX solution demands a considerable time to be installed and its integration with other client tools can't be done by the client, since he can't access to the operational system of the application. Any change must be provided by Critical Links or one of their agents or resellers. The IPBrick.IC is also based in Linux and can easily interact with other client applications. It's easy to reconfigure through only a remote access, but the application can't be easily integrated with proprietary solutions. IPBrick.IC only guarantees compatibility with applications based in open standards.

The project in group IV was exclusively developed to attend the specific needs of an university environment. The solution has been built attending to each department requirements and the majority of functionalities is available in other commercial solutions. The main intention of this project was not to target the business market, but the internal success of the project, allied with the needs of universities to establish a closer relationship with private companies, motivated them to follow this path. The PolySpeak provided by CICA department at FEUP has the same basic functionalities of Netcall and VipVoz IP-PBX solutions, but they have serious problems to guarantee an efficient technical support for their

external clients. They also have spent a considerable amount of time in the establishment of a business model that could support this new activity provided by FEUP. CICA chose the use of Asterisk as the basis platform of PolySpeak, however, they don't have enough technical competences to provide consultancy services based in Asterisk like the companies presented in group II. Instead, the Infrastructures and Communication Networks Unit at CICA, which was responsible for the development of the VoIP@FEUP project, can interact with others internal divisions at CICA that have technical competencies in terms of system administration, security and information systems. This turned possible for CICA to build a whole solution integrated with SIGARRA information system. However, it isn't easy for CICA to exploit all this knowledge from different divisions and bring it to the business market.

7 Framework for the Creation of Value with Open Source Software

7.1 Short Overview

In this chapter we propose a framework for the creation of value with Open Source software that takes into account the recent technologies in the field of telecommunications, leveraging on knowledge transfer between private companies, public entities and research centres. In a first instance (section 7.2) we present the analysis methodology that should be followed to describe and validate the instantiations of the framework. Secondly (section 7.3), we present a framework that extends the generic open source business roles model proposed by Eurescom. This framework intends to help telecom companies in the process of choosing their positioning in the telecom value chain and it is particularly suitable for a start-up company. Finally (section 7.4), we instantiate the use of this framework, presenting three representative and emergent scenarios for a company that operates in the Open Source telecom market.

7.2 Business Model Analysis Methodology

There are a lot of authors that give a definition of a business model and propose a brief list of components that should be included in the business model. The recent literature focuses on decomposing the business models into components and describes them with more detail. There are many scholars naming components to the business model, but Osterwalder and Pigneur (2007) version is one of the most complete and comprehensive work. First of all, they build their main building blocks out from well accepted strategy literature, such as Hagel and Singer (1999) and Markides (1999), and second, they have gone through all the other scholars lists of components to reveal the total amount of nine components (Hager, 2006). Besides, whatever method is used to identify components in the business model, there seems to be a fair similarity between the results. Often, components vary in its degree of abstraction leading to different numbers of components, but they basically describe the same model. A comparison of the components of Osterwalder and Pigneur (2007) and two of the most cited and distinguished research groups on business models, Afuah and Tucci (2000) and Chesbrough and Rosenbloom (2002) is illustrated in table 6.

Table 6: Comparing components of business models

Chesbrough and Rosenbloom	Afuah and Tucci	Osterwalder and Pigneur
Value Proposition	Customer Value	Customer Segments
Market Segmentation	Scope	Value Proposition
Revenue Mechanism(s)	Revenue Source	Communication Channels
Value Chain	Implementation	Distribution Channels
Cost Structure	Pricing	Customer Relationships
Value Network	Connected Activities	Key Resources
Competitive Strategy	Sustainability	Key Activities
	Capabilities	Revenue Streams and Cost Structure
		Partner Network

Source: Hager, 2006

Based on table 6, we can confirm that there are many similarities. There are differences in how the components are named, such as Customer Value and Value Proposition, Target Customer and Scope. The Customer Relationship and Distribution Channels are components included only by Osterwalder and Pigneur. Another component that differs is the Chesbrough and Rosenbloom component called Competitive Strategy, the same component that Afuah and Tucci calls Sustainability. This component can however be defined as a summary of the competitive advantages hidden in the rest of components. Thus, the competitive strategy component should be removed. This view is also supported by Magretta: “when a need model changes the economics of an industry and is difficult to replicate, it can by itself create a strong competitive advantage” (Magretta, 2002); supported by Christensen: “the business model can be a source of competitive advantage that is distinct from the firm’s market position” (Christensen, 2001); and also supported by Amit and Zott: “firms that address the same customer needs, and that pursue similar product market strategies, can nonetheless do so with very different business models (Amit and Zott, 2004).

In this dissertation we chose to use the Osterwalder methodology to describe and analyze each instantiation of the framework due to its completeness and acceptance in the business strategy literature. The Osterwalder methodology follows a three tier approach: firstly, it decomposes the business model into nine components; secondly, it assesses the business model using the SWOT analysis and package of key pertinent questions; thirdly, it tries to identify the potential innovation and improvement paths.

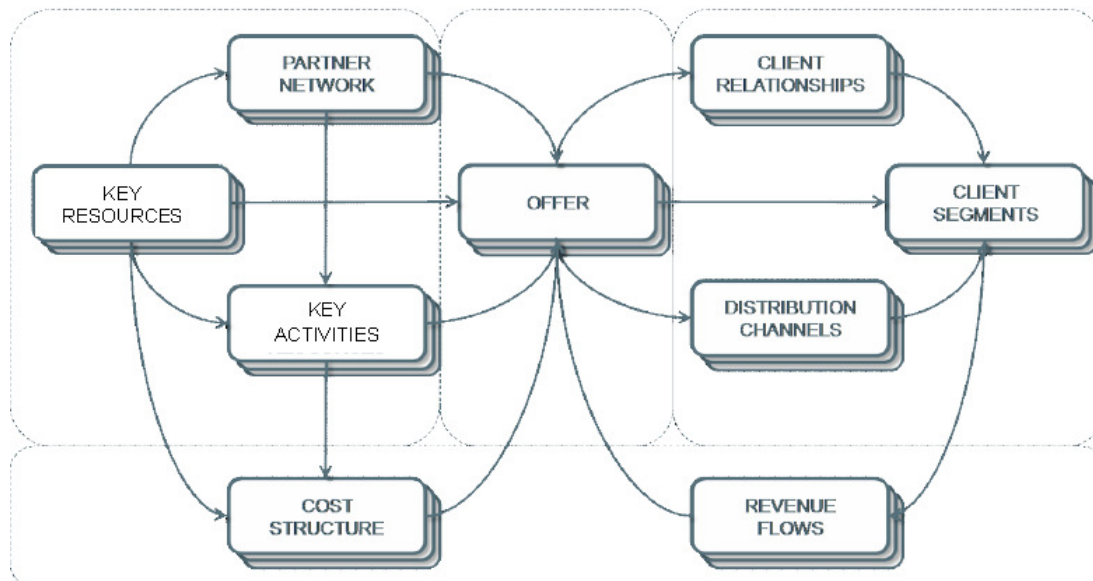
The next sections will describe in details each phase of this methodology.

7.2.1 Building Blocks of a Business Model

Conceptualizations of a business model try to formalize informal descriptions into building blocks and their relationships. While many different conceptualizations exist, Osterwalder proposed a synthetization of different conceptualizations into a single reference model based on the similarities of a large range of models, which constitutes a business model design template which allows enterprises to describe their business models (Osterwalder and Pigneur, 2007).

Following the Osterwalder vision, a business model can be described by looking at a set of nine building blocks, as we present in figure 59.

Figure 59: Building blocks of a business model



Source: Osterwalder and Pigneur, 2007

To get a good overview of a business model, we shall describe all of these components:

- Customer/Client segments: groups of enterprise's customers with distinct characteristics;
- Value proposition or offer: the bundles of products and services that satisfy the customer segments needs;
- Distribution channels: the channels through which the enterprise communicate with its customers and through which it offers its value proposition;
- Customer/Client relationships: the types of relationships the enterprise entertains with each customer segment;
- Revenue streams/flows: the streams through which the enterprise earns its revenues from its customers for value creating and customer facing activities;
- Key resources: the key resources on which the enterprise business model is built;

- Key activities: the most important activities performed to implement the enterprise business model;
- Partner network: the partners and suppliers the enterprise works with;
- Cost structure: the costs incurred to run the business model.

Customer Segments

Customers are the livelihood of every company since the revenue streams come from them. Successful organizations understand their customers. They strive to propose them an adequate offer that caters to their needs, they know how to reach them and they are aware of which relationships to build with them. Most importantly, from the enterprise perspective, successful companies know how to run satisfied customers into revenue streams.

A clear description and understanding of a company's customers is an integral part of every business model. More precisely, every company must ask if it is addressing their products and/or services to distinct customers groups with different needs and/or characteristics. For each customer segment the enterprise shall consider if it proposes them a distinct offer, if it reaches them through different communication and distribution channels or if they have a substantially different profitability.

We can consider two approaches to segmentation. The first approach, traditional segmentation, organizes customers by key variables such as demographics. The second approach, value-based segmentation, looks at customer needs as well as the costs of establishing and maintaining customer relationships.

Traditional approaches to customer segmentation are based on a number of variables that include:

- Geographic variables, such as region of the world or country, country size or climate;
- Demographic variables, such as age, gender, family size, income, occupation, education, socioeconomic status, nationality and others;
- Psychographic variable, such as personality life-style, values and attitudes;
- Behavioural variables, such as benefit sought, product usage rates, brand loyalty, product end use, readiness-to-buy stage, decision making unit, and others.

Today, the most successful companies practicing segmentation carefully, considering overall customer needs and segmenting customers based on those needs and overall business value. While this strategy is less scientific than the traditional approach, companies that have been successful at assessing groups of consumers both in terms of the revenue they generate and the costs of establishing and maintaining relationships have been reaping great rewards.

Segmenting customers into groups according to their needs has a number of advantages. It let a company:

- Identify the most and least profitable customers;

- Focus the marketing on the customers who will be most likely to buy products or services delivered by the company;
- Build loyal relationships with customers by developing and offering them the products and services they want;
- Improve customer service;
- Get ahead of the competition in specific parts of the market;
- Improve products to meet customers needs;
- Increase profit potential by keeping costs down and, in some areas, enabling the company to charge a higher price for its products and services.

Value Proposition

Value proposition can be defined as a business or marketing statement that summarizes why a consumer should buy a product or use a service. This statement should convince a potential consumer that one particular product or service will add more value or better solve a problem than other similar offerings (LRG, 2005).

Companies use this statement to target customers who will benefit most from using the company's products, and this helps maintain an economic moat. The ideal value proposition is concise and appeals to the customer's strongest decision-making drivers. The value proposition shall answer the following key questions:

- What do we offer the market?
- What is the specific bundle of products and services that can be offered to the customers segments?
- Which customer needs does each value proposition cover?
- Do we offer different services levels to different customer segments?

With the description of the client segments and the corresponding value propositions we have already outlined the heart of a business model. Following Osterwalder vision: "this is the kernel of a business model, but yet only the most basic part" (Osterwalder, 2008).

Communication and Distribution Channels

A company reaches its customers through various communication and distribution channels. They represent the interface between a company, its value propositions and its customers. These customer "touch points" include advertising, retail outlets, sales teams, websites, conferences, sales affiliates, among others. The means a company can use to reach its customers have multiplied over the years, which have left managers with a large set of design choices to reach their customers.

Communication and distribution channels have become increasingly important in business model design. Osterwalder agrees that a good and integrated channel design can be a

powerful tool for differentiation and competitive advantage. For example, cost intensive channels should be used for very profitable clients, while unprofitable clients should be served through cost efficient channels.

Communication is the main source to promote products or services of an organization. It is the source to communicate within the organization, outside the organization and to deal legal issues. Business communication covers a wide range of business topics such as marketing, customer relations, advertising, branding, customer behaviour, public relations, research and measurement, interpersonal communications, etc. Identification of the customer audience and its requirement for right business communication solutions is a core task. The company must choose a better channel to convey its message because the communication channel depends on the message.

Distribution is all about getting the products/services of the company to the right people at the right time with special consideration for profit and effectiveness. Successful marketing does not end when a business has developed a product/service and has found its appropriate target audience with a view to selling it at the “right price”. The next issue that needs to be faced is how the company is going to distribute and sell his product/service to consumers. When a product/service is purchased by a consumer, it may have been bought directly from the business, or through a number of intermediaries (wholesaler, retailer, etc). Distribution channels are influenced largely by the type and size of the business and so some of the distribution channels may not be feasible for a particular business. Consequently, the company may note that these channels could be adopted in the future to accommodate for any changes and to help the business grow.

Customer Relationships

Getting relationship management right in a business model is crucial to satisfy customer's expectations. For instance, customers paying a high price for a product or service will expect a high touch relationship, while customers paying a cheap price do not expect more than automated, yet customized relationships. One important aspect is to define if the company will develop and maintain different types of client relationships in its business model and to estimate how resource intensive is each of these client relationship types in terms of time consumption and other costs.

The concept of Customer Relationship Management (CRM) is already implemented in the market in several sectors of activity and represents an information industry term for methodologies, software and, usually, Internet capabilities that help an enterprise manage customer relationships in an organized and efficient manner. In many cases, a Network Operator builds a database of its customers. This database describes relationships in sufficient detail so that management, salespeople, and customer service agents can access information, match customer needs with product plans, remind customers of service requirements, know what other products a customer had purchased, etc.

Baaken and the general literature about CRM consider three parts of application architecture of CRM (Baaken, 2007):

- Operational CRM – means supporting the so-called “front office” business process, which includes customer contact (sales, marketing and service). Tasks resulting from these processes are forwarded to employees responsible for them, as well as the information necessary for carrying out the tasks and interfaces to back-end applications;
- Analytical CRM – in analytical CRM, data gathered within operational CRM are analyzed to segment customers or to identify cross and up-selling potential. Data collection and analysis is viewed as a continuing and iterative process;
- Collaborative CRM – facilitates interactions with customers through all channels (personal, letter, fax, phone, web, e-mail) and supports co-ordination of employee teams and channels. It is a solution that brings people, processes and data together so a company can better serve and retain their customers.

Revenue Streams

A business model's sustainability depends on the revenues it can capture from the value creating and customer facing activities. Revenue streams come from one or several segments of clients who are willing to pay for the value they get from the offer. These typical revenue streams come in the form of selling, professional services, lending, licensing, commissions, transactions fees or advertising fees.

If the IT organization is charged with selling and supporting technology products, the company shall track several key indicator trends to monitor the business. Key indicators and information to track include the following:

- Total revenue by product trend – this is the total sales of each product by month;
- Net revenue by product – reduces the total sales number by direct product costs tied to generating the sale (i.e., advertising that can be directly related to a single product, labor required to package and ship the product, etc.);
- Net profit by product – reduces the net revenue number by expenses that should be applied to the product;
- Total clients – track of the company clients;
- New clients – track of the new clients added each month;
- Maintenance revenue – the revenue generated from ongoing support maintenance;
- Source of sale – whenever possible, the company shall tie new sales to the source of the sale to help the company see what marketing methodology works and what doesn't. The source might be an advertising campaign, a particular sales representative, client referrals, the web site, etc.;
- Revenue per client – the company shall track how much of its clients are buying their products.

On the contrary, if the IT organization is charged with offering professional services, that typically include custom programming, consulting and training, the company shall also track

some key indicators. Unlike product sales, professional services can vary by contract and are more dependent on having staff with certain expertise available to deliver the services. Because staff expenses are typically the higher costs in a company, failure to monitor this segment of the business can have devastating effects on the financial plan. Key indicator trends that a company shall monitor and measure for professional services include the following:

- Revenue – total monthly revenue trend;
- Average revenue per billable employee – average revenue per month that a billable employee generates;
- Revenue per employee – monthly revenue contribution per billable employee;
- Billable hour percentage – useful for those employees that are billable per hour;
- Bench availability – monitor who is on the bench now and who is coming to the bench. If resources are on the bench, those resources are not billing. Another use of this is to plan resource bench availability in order to coordinate additional training for those resources;
- Employee referral – often, additional revenue can be generated by an employee who is working with a client.

Typically a company likes to present these financial indicators in terms of graphs showing the revenue streams from each customer segment and the percentage of contribution of each revenue stream to the overall revenues.

Key Resources and Key Activities

At the basis of every business model there is a set of key resources a company must dispose of to make its business model work. These key resources include classical ones, such as human resources and tangible assets, like installations and reliable IT systems. However increasingly, business models are also built on intangible assets that are difficult to quantify, such as brand equity and expertise of a specific domain.

To implement a business model a company needs to perform a number of key activities. These activities comprise the crucial actions and assigned tasks that have to be performed to run the business model. They can be performed by the company itself or they can be done through a network of partners.

Partner Network

Today's Business Models are more and more the result of network partnerships, joint ventures, cooperation and alliances between different companies. Partners are involved, for example, to complement the value proposition, to bring in specialize competencies or to help on the delivering to clients.

Every company must ask itself if and how it can leverage its own business model by partnering with other companies. This includes the question of what a company wants to do by itself and what it wants to do with partners. It also includes the question of leveraging one's own value proposition by combining it with the value proposition of strategic partners.

A partnership agreement shall be an effective method of helping each of the partners to:

- Agree to share a vision to collaborate together;
- Set up mutually acceptable goals;
- Specify the basis on which to begin working together;
- Make sure that each of the partners are clear about what needs to be achieved;
- Assess the effectiveness of the agreement;
- Bring out issues related to accountability and responsibility;
- Lay a strong foundation that can sail through difficulties and testing time ahead.

Cost Structure

The cost structure is a direct result of all the other building blocks of the business model. Ideally, costs should be traceable back to each business model; however, in some businesses, it is difficult to separate these blocks, especially the key resources and key activities, because some of these activities can't be done if some of these key resources aren't available.

Looking to the cost analysis and understanding the nature of cost behavior are extremely important for the management staff of a company. These factors will allow the company to estimate potential costs and levels of production as the company monitors current costs and productions. Costs are a major factor towards decision making within any business and the company is internally always formulating questions like:

- How can we reduce costs and still boost revenue?
- Are we able to cut prices to boost worth for the consumer?

All these decisions about cost are aimed towards maximizing the profit of the company and getting most out of its business (Atkinson et al, 2007).

The costs structure of a business is based on the composition of fixed costs and variable costs. Fixed costs are those costs that don't change for different levels of output and sales. Rent and expenses for previously bought equipment are two types of fixed costs. On the other hand, variable costs are those costs that change for different levels of output and sales. Most obvious categories of variable costs are materials and labor related to the production of goods. Some discretionary expenses such as advertising, travel and employees perks are treated as variable costs.

Usually, we can admit that businesses with high fixed costs are forced to find a wide audience as quickly as possible to make those costs worthwhile (Hengeveld, 2008).

7.2.2 Business Model Assessment

In the previous section we presented the first phase of the Osterwalder methodology to describe a business model by going through each of its building blocks. Now, after we have described the business model in detail (the first phase of the methodology), we have the elements to start assessing it (the second phase of the methodology). We achieve this by asking a number of key questions that crystallizes a business model's strengths, weaknesses and highlights opportunities and threats. This analysis is also known as SWOT analysis.

In a SWOT analysis, strengths and weaknesses are internal factors. A strength could be:

- A new, innovative product or service;
- A specialist marketing expertise;
- Quality of processes and procedures.

A weakness could be:

- Undifferentiated products or services (in relation to the competitors);
- Poor quality of goods or services;
- Damaged reputation.

On the other side, opportunities and threats are external factors. An opportunity could be:

- Mergers, joint ventures or strategic alliances;
- Moving into new market segments that offer improved profits;
- A new international market.

A threat could be:

- Price wars with competitors;
- A competitor with a new, innovative product or service;
- Competitors with superior access to channels of distribution.

The analysis described above will give the basis to reflect on an improved business model, and it also can include some major innovations.

Attending to the Osterwalder model, we can also formulate some questions to each building block that complements the SWOT analysis and gives a good way to assess the business model. We can consider the following questions:

Customer segments

- Do we know our customers and their needs good enough?
- Are some customer groups likely to defect soon?
- Do we regroup different customers segments well enough?

Value proposition

- Does our value proposition still cater well enough to our clients' needs?

Creation of Value with OS Software in the Telecommunications Field

- Do we know how our customers perceive our value proposition?
- Are our competitors offering similar value propositions at similar or better prices?

Revenue streams

- How sustainable are our current revenue streams?
- How diversified are our revenue streams?
- Are we dependant in too few revenue sources?

Communication and distribution channels

- Do we have a well thought-through communication and distribution channel design?
- Do we know how successful our channels are in terms of customer acquisition?
- Do we use the right channels for the right clients?

Customer relationships

- Do we have a customer relationships strategy?
- How good are our relationships with our best customers?
- How well are we doing in managing our customer relationships?

Key resources

- Do we possess the right key resources in terms of quality and quantity?
- Do we possess too many resources internally, leading to a lack of focus?

Key activities

- How efficient are we in performing our activities?
- Do we perform too many activities ourselves, leading to a lack of focus?

Partner network

- Do we use partners enough?
- How well do we work with our existing partners and suppliers?
- How dependent are we on our existing partners and suppliers?

Cost structure

- Is our cost structure appropriate?
- Do we clearly understand which parts of our business model have the highest costs?
- How lean is our cost structure?

7.2.3 Business Model Innovation and Improvement

After having assessed and described a business model, the challenge remains its renewal. The most important steps towards business model improvement and innovation have already

been taken once we have drawn a clear picture of the current business model. Besides that, innovation scenarios and improvement proposals can be built on the conclusions of our business model assessment, including strengths, weaknesses, opportunities and threats.

Business model innovation involves a wide spectrum of original concepts, including the development of new ways of doing business, new business models, business application of technology and communications, new management techniques and new forms of stakeholder participation. In some cases, the innovation rests not in the technology, in the product or in the service, but in the business model itself. Another challenge, particularly important in the Open Source world, is to define an innovation methodology that takes into account the appearance of value-creating networks, which includes several entities (individuals or organizations) that transform and transfer different kinds of resources in order to create value not only for the network's end customer but also to themselves (Helander & Rissanen, 2006).

In this step, we shall ask ourselves if and how we want to change each business model building block to arrive at a better business model (the third phase of the methodology). At this stage, it is very valuable to let the imagination flow freely before narrowing down ideas to feasible projects.

To achieve business model improvement and innovation, we shall ask ourselves the following questions attending each building block:

Customer segments

- Are there new customer segments we could serve?
- Could we regroup/segment customers better according to their needs?

Value proposition

- Could we offer our different customer segments more tailored needs?
- Do our customers have other needs we could satisfy relatively easily by ourselves or with partners?
- Could we complement our value proposition through agreements with partners (e.g., joint value propositions)?

Revenue streams

- Could we introduce new revenue streams (e.g., lending/renting instead of selling)?
- Could we do more cross-selling (e.g., offer our customers other products of our company or of partner companies)?

Communication and distribution channels

- Could we increase our customer base by better using our channels?
- How can we better use expensive channels for highly profitable clients and cost efficient channels for unprofitable clients?
- Could we introduce new communication and distribution channels to reach our customers (e.g., partner distribution agreements)?

Customer relationships

- What level of personalization does each of our customer relationships require?
- How can we spend less time and resources on unprofitable clients?
- Should we introduce frequent buyer programs?

Key resources

- Are there some key resources we could get rid to our partners?
- Are there some key resources that could be better and cheaper supplied by partners?

Key activities

- Are there activities we would better outsource to partners?
- Are our activities adapted perfectly to our value proposition?
- How could we streamline activities?

Partner network

- Which partners could help us to complement our value proposition?
- Which suppliers could help us streamline our business model?

Cost structure

- Are there ways we could reduce our cost structure (e.g. partnering, outsourcing, setting new suppliers, etc.)?

7.3 Open Source Business Roles Model

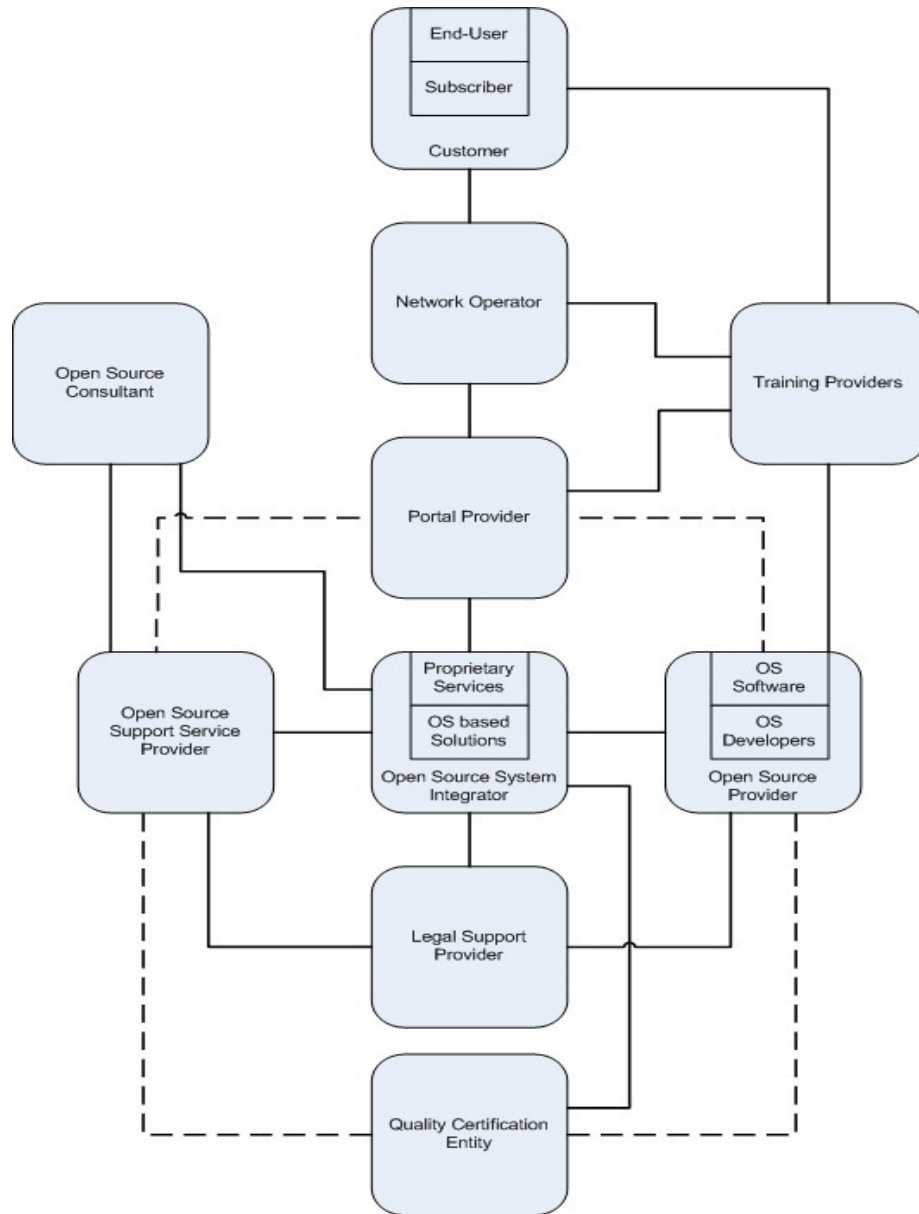
Attending to the section 3.5 of this thesis, where we presented the most important Open Source business models, we concluded that all business models for Open Source are based on the premise that software is a service. Actually, the self-understanding of software industry is changing from a factory model, which tends to view software solutions as finished goods, to a service model. Even Microsoft said that its software effort will evolve into a service business and that Microsoft's future turnover should no longer mainly come from selling software licenses but more and more from selling software services (Eurescom, 2001).

For the creation of a common Open Source business process, a new framework that constitutes a new extended open source business roles model with clearly assigned tasks and relationships has to be provided. We formulated this model taking in consideration the European Institute for Research and Strategic Studies (Eurescom) strategic study about Open Source in telecommunications operator environment, the actual and new tendencies of value chains and business models in telecom industry (section 2.3 and 2.4) and the feedback received from the case studies analyzed in chapter 5. We chose to give a special attention to the Eurescom Strategic Study for our research work, because it is the most complete study conducted by big operators about the impact of OS software in the international telecommunications market. Besides that, the Eurescom study reports have a high

international reputation and the European Institute for Research and Strategic Studies is considered a leading organization for managing collaborative R&D in telecommunications. It has a strong experience of seventeen years in the management and support of R&D projects, programmes and initiatives to its customers.

The Open Source business role model is illustrated in figure 60.

Figure 60: Open Source business role model



The Open Source business role model encompasses ten roles and certain relationships between these protagonists. The lines in the figure describe the relationships between the different roles. The lines indicate which role provides input to another role within the Open Source business process. The dashed lines indicate that some inputs could be provided directly, but this is not the most typical case. The relationships between each entity will be instantiated and analyzed in detail for each scenario presented in the section 7.4 of this thesis.

The roles, tasks and relationships illustrated in figure 60 are described below:

- **Open Source Providers** – mainly develop, improve and release Open Source software. The Open Source Provider role provides both Open Source software and Open Source developers. Open Source developers generally provide Open Source software, but, in some cases, could also be utilized for the development of proprietary services. Relationships exist to Open Source System Integrator, Legal Support Provider, Training Provider, and, optionally, to the Portal Provider and Quality Certification Entity;
- **Open Source Support Service Providers** – sell support services for Open Source products. Open Source support services encompass Open Source product related failure handling, adding of new features to the Open Source product, versioning, among others. Open Source support services don't provide maintenance services for the whole Open Source system solution. Open Source Support Service Providers provide input to the Open Source System Integrator and optionally to the Portal Provider, and gets input from the Legal Support Provider, Open Source Consultant and optionally from Quality Certification Entity;
- **Open Source System Integrator** – use Open Source software in order to build Open Source based system solutions. Apart from Open Source services also proprietary services can be implemented upon Open Source systems. The Open Source System Integrator gets input from Open Source Provider, Open Source Support Service Provider, Open Source Consultant, Legal Support Provider and Quality Certification Entity, and provides itself input to the Portal Provider role;
- **Open Source Consultant** – provides consultant services about Open Source solutions based on his previous scientific and/or professional experience. Open Source Consultant provides input to the Open Source Support Service Provider and Open Source System Integrator;
- **Legal Support Providers** – offer the necessary legal support for formulating, using and understanding Open Source licenses. They provide input to the Open Source Support Service Provider, Open Source System Integrator and Open Source Provider roles and get input from the Open Source Provider role that provides the Open Source license for their Open Source products. This role can be provided by a private company or by the Software Freedom Law Center (SFLC). The SFLC provides legal representation and other law-related services to protect and advance Free and Open Source Software (FOSS) offering direct services to non-profit FOSS developers without charge, as well as public publication for any external entity. According to Eng. João Belo from Critical Links, the use of these consultancy services will be especially suitable in an initial phase, before the product is available at the market. More details about the SFLC can be found in the annex O.

There are other entities (individual legal experts and professional companies), essentially in Europe and USA, that provide legal support in Open Source solutions. A list of these companies can be found in: <https://fossbazaar.org/?q=resources/legalServices>.

- **Quality Certification Entity** – provides certification in the field of software and processes. It provides direct input to the Open Source System Integrator and optionally provides input to the Open Source Provider and Open Source Support Service Provider;
- **Training Providers** – offer training services to company that wants to use and configure Open Source solutions. They get input from the Open Source Provider and provide inputs to the Portal Provider and Network Operator, or directly to the Customers;
- **Portal Provider** – manages the aggregation of specified converged services and technical Open Source solutions. This entity can also be responsible for the packaging and marketing of services for end users segments. It gets inputs from the Open Source System Integrator and Training Providers, and also optionally from the Open Source Support Service Provider and Open Source Provider, and provides input to the Network Operator;
- **Network Operator** – carries and delivers data and web content to the customer. It can encompass the role of a broadcasting networking operator or mobile network operator. Typically, it is responsible to provide network connectivity, location and presence information, access to billing systems, customer databases and management of quality of services. It gets input from Portal Provider and Training Provider, and provides inputs to the Customers;
- **Customers** – buy and use Open Source system solutions. Customers get inputs from the Network Operator and Training Providers.

The study conducted by Eurescom in 2001 already considered the relationships between Open Source Provider, Open Source System Integrator and Open Source Support Service Provider entities. They also introduced the idea of a Legal Support Provider entity that could help the companies to deal with the issue around the conflict of licenses between proprietary and Open Source programs and libraries. However, they didn't concretize which entities would be responsible to assume the Legal Support Provider role. Other entities, such as the Portal Provider, the Open Source Consultant, the Training Providers, the Quality Certification Entity and the End-Customers were introduced by this PhD project for the first time. It's also important to notice that the Eurescom study considers that the Customer role of their model is performed by the Network Operator. In our PhD study we separate these two entities and we give a special attention to the end-user needs for each considered application scenario.

In the following, we present three scenarios as concrete and relevant examples applying this abstract business role model in order to verify the generic validity of this Open Source business role model. Some of the roles described before will not be totally present in all three scenarios, because some entities can aggregate the role of others. We will use the Osterwalder methodology to analyze and evaluate each of our scenarios.

7.4 Application Scenarios

7.4.1 Overview

The first scenario that we considered is the introduction of a unified communications solution by the Network Operator. This is a recent tendency in the international market that targets essentially the SMB market and can be considered a very successful approach, even if the appearance of these solutions is still in a young phase.

Nowadays, the concept of hyperconnectivity is here and affects the way we communicate. This phenomenon creates both challenges and opportunities. Challenges in terms of lower personal productivity and unsatisfied employees, ineffective distributed teams and missed milestones or poorer quality of deliverables, on-hold business processes and connectivity mayhem; opportunities to simplify and manage communications and also to cut through the complexity of multiple devices. A unified communications solution will help to remove the barriers between voice, email, conferencing, video and instant messaging. For the hyperconnected enterprise, this means reduced time to decision, increase productivity and the ability to provide a simple and consistent user experience across all types of communications.

Secondly, we formulated a typical scenario where the Network Operator wants to introduce a VoIP solution based in an Open Source platform. In this situation, the users of broadband Internet access will have the possibility to make phone calls to other VoIP users and regular phones and use other services such as voice mail and fax mail applications (to reduce the need to print documents) associated to email applications.

VoIP takes advantage of the Internet Protocol by using packet networks to transmit voice data. The use of a VoIP provides important cost savings over traditional land-line and cell phone long distance charges. For a PC-to-PC phone call it can even be no costs involved, being the computers placed anywhere in the world (providing they have the VoIP service installed). While there is usually a cost to make PC-to-phone connection, it is usually less than a traditional phone call using the PSTN network. Besides that, there is another strong benefit in terms of portability. As long as we have access to a broadband connection, we can easily and cheaply keep in touch with our business or personal affairs. This portability is available for phone-to-phone VoIP service as well. The VoIP service provider will provide an Internet phone number that follows the user wherever he goes.

Finally, in the third scenario we will consider a situation where the Network Operator wants to provide a converged fixed-mobile solution using a IMS architecture. The IMS is a set of specifications that describes the NGN architecture for implementing IP based telephony and multimedia services. IMS defines a complete architecture and framework that enables the convergence of voice, video, data and mobile network technology over an IP-based infrastructure. IMS aims to standardize network interfaces and avoid fractured technologies and proprietary products.

IMS was initially defined by the 3GPP project in 1999. However, even if there are several R&D projects around this technology, it isn't still intensively used in commercial projects. There are still some open issues in categories such as business, interoperability and hardware

compatibility. It is still in debate the choice of the correct strategies for doing business in a multi-carrier-vendor environment, the interoperability and interconnectivity with existing network infrastructure and there is a lack of high-quality “dual-mode” capable handsets.

However, the use of IMS over the existing cellular network infrastructure presents important benefits. The IMS provides a common platform to reduce time-to-market for rolling out new multimedia services. At the same time, it allows operators to charge multimedia sessions appropriately, allows all services to be available irrespectively of the users’ location and provides multimedia services with QoS ability.

7.4.2 Scenario I: Unified Communications Solution

7.4.2.1 *Idea/Purpose*

In this first scenario we propose an approach where a Network Operator wants to offer a unified communications solution to attend their customers’ needs. This infrastructure shall be a multi-functional network appliance with support for networking, data, voice and IT services. For example, it shall attend the following requirements:

- Networking: High speed Internet access, network management (DNS, DHCP and NAT), firewall, VPN connections and bandwidth management;
- Voice: IP-PBX and VoIP Gateways;
- IT Services: File system sharing, printer sharing, email server, backup servers and remote web management.

All these services shall be integrated in a single, reliable device that is easy to use, easy to manage and scalable, that will replace standalone IT network management equipments. This approach will let the customer company avoid expensive support, will decrease dramatically the exposed security vulnerabilities and the customer will not need to deal with multiple suppliers anymore.

Using the Open Source paradigm, a Network Operator may take advantage of its own good knowledge of the market and in-house labs, to quickly respond to a requirement of the market. For that, the Network Operator should be a sponsor of a community dedicated to developing the technical infrastructure, including protocol stacks, middleware and end-user services. The community would reuse as much existing Open Source software as possible (e.g., Linux, Apache, Vovida, Jabber) by creating partnerships with other communities and would try to create a kind of Open Source community chain.

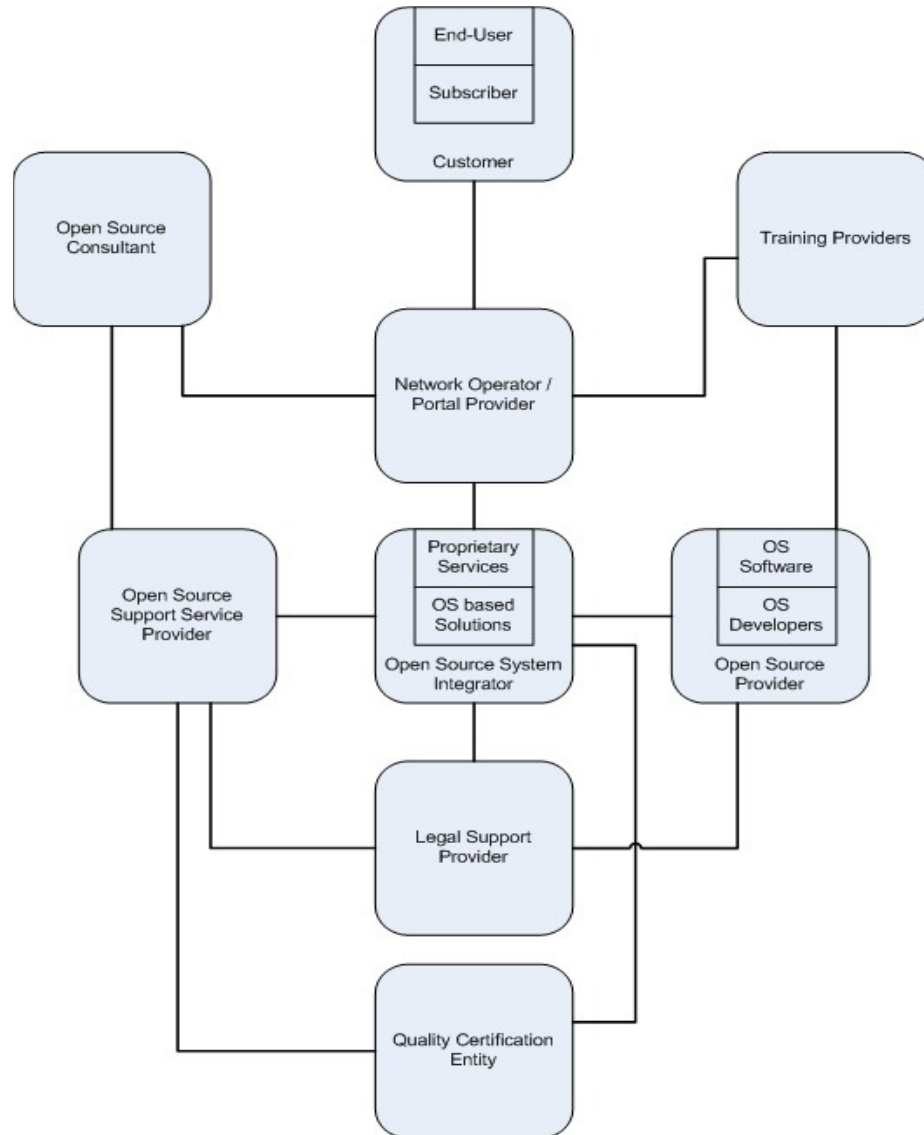
Two different levels of Network Operator involvement in the software development process can be devised:

- Lighter Involvement – the Network Operator in this role would spend few resources in the community. It would help the Open Source development to focus on the real needs of the market, by reporting bugs, making feature requests and giving general feedback. On the other hand, it would spend more on the purchase of products and support services that are based on the Open Source software produced by the community;

- Deeper Involvement – the Network Operator in this role would spend more resources in the community, not just reporting bugs and making feature requests, but also participating in the production of the actual code, either by testing the various pieces of software in various environments, or by tracking, reproducing, isolating and fixing problems reported by the user community.

Based on figure 60 of the previous section, we can instantiate and adapt it attending to the specific requirements of this scenario (see figure 61).

Figure 61: Diagram of scenario I



In the deeper involvement approach, the Network Operator/Portal Provider can be joined to the Open Source System Integrator. A tight integration between Network Operator and Portal Provider puts communication and collaboration into the context of the user's business environment. Besides that, it enhances the service provider offering making it possible to

provide a single device that is responsible to manage the network of the company and allow inter-offices communications and the communication with external stakeholders.

Following this approach, the Network Operator would still purchase products and support related to the Open Source software produced by the Open Source System Integrator. The Open Source System Integrator would be responsible for the assembling of the unified communication system, including OS applications developed by the Open Source Provider and getting support services, such as failure handling and versioning, from the Open Source Support Service Provider.

The Open Source Support Service Provider has an important positioning in this scenario. It is responsible for the monitoring of IT networking and the detection of the sources of failures, due to maintenance procedures, power outage, hardware errors, software errors, congestion or malicious attacks. This entity can offer an integrated fault-injection tool to evaluate the detection efficiency in terms of both failure detection coverage and latency by fault-injection experiments. At the same time, the Open Source Support Service Provider can also provide individual versioning for some networking components, avoiding the Network Operator from launching a new version of a unified communications to the market.

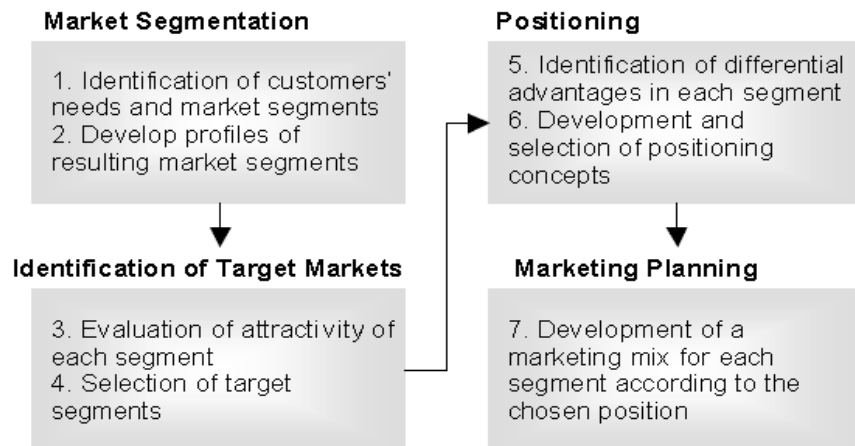
The Quality Certification Entity can have a key role in this scenario. The Open Source System Integrator must guarantee a high level of interoperability between the different OS components that composes the Unified Communication Solution. At the present time, there is a general lack of quality certification when it comes to solutions that build on multiple Open Source components, where a change in one underlying component can break the entire solution (Polesse ref. Galli, 2008). Therefore, the role of the Quality Certification Entity is to assure that OS solutions will continue to work together over update cycles before it has been widely integrated and used by companies that adopted the Unified Communications solution.

The other entities showed in this scenario will have the typical behaviour described in section 7.3.

7.4.2.2 Building Blocks

Customer Segments

The importance of market segmentation results from the fact that the buyers of a product or a service are not an homogenous group. Actually, every buyer has individual needs, preferences, resources and behaviours. Since it is virtually impossible to cater for every customer's individual characteristics, marketers group customers to market segments by variables they have in common. These common characteristics allow developing a standardized marketing mix for all customers in this segment. This marketing mix is composed by the 4P (Product, Price, Place, Promotion). Literature suggests the following steps for the creation of a marketing mix segment (shown in figure 62):

Figure 62: Vision of marketing mix approach

Source: Kotler and Keller, 2006

In theory, there is a huge number of variables that could be used for market segmentation. They comprise easy to determine demographic factors as well as variables on user behaviour or customer preferences. In addition, some of these segmentation variables can be more appropriate for consumer markets or industrial/business markets.

Attending to our scenario, the Network Operator can deploy Open Source solutions directly to consumer markets or to business markets. In our study, we will focus in business market and we will consider segmentation based in technology. This segmentation is the most suited to realize the benefits of actual Open Source solutions existent in the market and doesn't invalidate a more detailed segmentation inside each technologic segment.

The Network Operator can establish segmentation based on the nature of software developed product, namely attending to the infrastructure of software and enterprise application software as we show in the following table.

Table 7: Segmentation of a Network Operator based on software solutions

Infrastructure Software	Enterprise Application Software
Application integration and middleware	Customer relationship management
Business intelligence tools	Enterprise resource planning
Database management systems	Supply chain management
Data integration tools	Project portfolio management
Security software	Content, communication and collaboration

Source: Kotler and Keller, 2006

In the Open Source market we can already find some standard solutions in the segment of infrastructure software. For example, as business intelligence tools we have already the Pentaho and Jaspersoft solutions and in the database market we can find the MySQL and PostgreSQL. In the segment of Enterprise Application Software we can find the Sugar CRM as a very successfully project in the field of Customer Relationship Management. This Open Source solution is used, for example, by Critical Software and Critical Links companies. As content and collaborative tools we can find the Alfresco software, which is an Enterprise Content Management Solution (CMS), and the Plone project, which is another CMS,

especially targeted for the creation of websites and to share content between several partners and Internet users.

These technologic solutions can address different customer segment markets. The most typical segments that a Network Operator can address are the following:

- Private and business customers;
- Residential customers;
- Telcos carriers;
- Retail shops.

In this scenario we will focus particularly in the SMB market. The SMB market is a large market to target, which produces about 50% of the revenues in the UK/US. Besides that, broadband managed services will represent a strong growth market between 2007 and 2010. Analysis forecasts that total revenue from value-added services, including firewalls, virus protection, email, Web hosting, VPNs, VoIP services, storage solutions, managed LAN servers and managed Windows desktops, will grow from €1.1 billion in 2003 to €10.3 billion in 2008 (www.analysis.com, 2007).

The SMB is characterized to require solutions that are easy-to-use, available off-the-shelf (with little customization) and no specific skills to operate, which means a fast learning curve. These companies require fast return on investment (ROI), visible cost savings and business benefits with lower total cost of ownership (TCO). However, they don't have enough internal IT resources or know-how to manage their broadband services. They prefer to have a specialized partner that can be "extended" IT personnel.

The edgeBOX, a product launched by Critical Links addresses precisely the SMB market. In his interview, João Belo admits that the rules of the game have changed, and nowadays a lot of new technologies have become critical to the operations of a SMB company. By being able to deploy a single edgeBOX appliance, businesses can have their communications networks up and running in a matter of hours, even in greenfield deployments, delivering a single plug and play resource for converged voice and data applications. In addition, the edgeBOX provides a Unified Management Interface that simplifies management functions so that staff with limited IT expertise is able to effectively maintain the network resources.

Value Proposition

Applications are actually changing the value proposition of a Network Operator, with the advent of a third generation of digital real-time communication (Kim, 2007). That means a shift of the voice (or text) value proposition for mass market customers. However, the value proposition for the customers remains significantly the same independently of the technology type that is used (Open Source or proprietary technologies). This value proposition is focused in the user needs and requirements. Attributes like mobility, flexibility, security, reliability and interoperability will be standard attributes either for close-source solutions or Open Source solutions.

The value proposition shall also take into account the pre-existed IT infrastructure of the customer. If the Network Operator is dealing with a greenfield IT scenario, which means that the company has no networking equipment, then the value proposition shall offer a low price to the all Unified Communications system. In his interview, João Belo considers that Critical Links is mainly looking for these kind of customers, that will especially get strong benefits from an Unified Communication device. However, as he admits, green-field start-up prospects are hard to find and highly coveted by all account executives (Belo, 2008). On the other hand, if the customer already has an established IT network, then the value proposition shall give a special attention to the scalability of the solution. Typically, these customers will see a Unified Communications system as an expensive upgrade. Therefore, it is important to give them the opportunity to upgrade and test it step by step. Typically, only after this first step, these kind of companies are ready to adopt the entire Unified Communications system.

However, the value proposition offered by an Open Source Provider or an Open Source Support Service Provider to a Network Operator/Portal Provider will be totally different if they are using Open Source solutions. An Open Source approach is designed to open up their code to developers, to expose bugs, to share technology, to promote interoperability, and to accelerate adoption of their technologies.

In his interview, Raúl Oliveira assumes that the main business of iPortalMais is to sell their knowledge to their partners to make sure that they are able to enjoy all the Linux OS benefits with their customers, without the need of being Linux experts. The internal management process is adapted to the characteristics of the OS community and the project managers adopt a flexible position in order to be able to work closely with this community. The use of OS solutions based in open standards facilitated the integration between several network and communication services.

Communication and Distribution Channels

New technologies have radically changed buying and contact behaviour. Call centres, Internet and e-mails are increasingly replacing letters, faxes and even the trip to the store. The network operator needs to merge new and old communication channels in an integrated multi-channel solution and shall take advantage of the viral market concept.

The marketing concept of a business is to firstly define its primary goal. This goal for viral marketing is to reach as many potential customers as possible in the shortest time and at the lowest possible cost. This goal can be reached by using the unique concept of “word of mouth”. A key element responsible for the wide spread recognition of the product is the personal recommendation of the word of mouth contact, like of opinion leaders.

Fritz differentiates between two goals, the economic goals and non-economic goals, although the non-economic goals play a more dominant role at the beginning of a marketing campaign (Fritz, 2004). Non-economic goals are:

- Customer acquisition;
- Customer satisfaction;

- Customer loyalty;
- Degree of popularity.

Before a product or service is put on the market with the use of viral marketing it is important to determine which segment of the population will profit the most from the marketing campaigns.

The magic word for any customer is “free” and this can be an important motivation factor. With e-mails, web sites, graphics and software download, the spreading of the message is easy and cheap. But the word “free” can be confused with the terminology of “free software” and “open source software”. Build an Open Source based solution doesn’t mean necessarily to get no money from the software itself or from services associated with the software solution. More attention will be given to this situation in the section of “revenue stream”.

The choice of the right distribution channel is influenced by 3 kinds of factors:

- Market factors – an important factor is “buyer behaviour”, namely how do buyers want to purchase the product. Another important factor is the buyer needs for product information, installing, servicing and technical assistance. This factor was considered when the iPortalMais thought about the possibility to launch its solution to the residential market. The IPBrick.IC should be changed in order to simplify the installation and configuration processes to avoid the need of exhaustive technical assistance;
- Producer factors – a key question is whether the Network Operator has the resources to perform the functions of the channel. For example, a Network Operator may not have the resources to recruit, train and prepare a sales team. If so, the only option may be to use agents and/or other distributors. Another factor is the extent to which Network Operator wants to maintain control over how, to whom and at what price a product is sold;
- Product factors – usually large complex products are often supplied directly to customers. By contrast, standard products are ideally suited for using intermediaries such as retailers.

There are three broad options to choose a distribution channel: intensive, selective and exclusive channels.

Intensive distribution aims to provide saturation coverage of the market by using all available outlets. Intensive distribution is not particularly suitable for a network appliance, because customers don’t have a range of acceptable brands to choose from. If one brand is not available, a customer can’t simply choose another one.

Selective distribution can be considered the most suitable distribution channel for this scenario. This distribution process involves a producer using a limited number of outlets in a geographical area to sell products. An advantage of this approach is that the Network Operator can choose the most appropriate or best-performing outlets and focus effort (e.g., training) on them.

The other option is to choose an exclusive distribution. This distribution process is an extreme form of selective distribution in which only one wholesaler, retailer or distributor is used in a specific geographical area. This distribution process can only be selected if the presence of a specific retailer is an important competitive advantage for the company.

Customer Relationships

Establish a right customer relationship strategy is an extremely valuable asset for a Network Operator. Relationships between a company and their customers, distributors, employees, referral sources, are vital to continued, sustained growth and stability. Loyal relationships with these valued individuals make for a strong bottom line.

A traditional approach of a customer relationship management system tries to focus its analysis in the direct relationship between a company and its customers. This situation is still valid for our scenario, because Network Operator can still manage direct connections with its customers. However, in the most typical situation, the prospection of new customers is made by local resellers of the IT Unified Communications product. Therefore, it is important to consider a partner relationship management strategy.

A partner relationship management is a business strategy for improving the communication between companies and their channel partners. However, exchanging information about customers, sales opportunities and marketing activities with a network of resellers can be complex and time-consuming. One way to avoid this issue is consider a web-based partner portal. The web-based partner portal increases the channel productivity by reducing the time and money spent communicating with all partners, resellers, distributors and retailers.

The use of a web-based partner portal will bring the following advantages to the Network Operator:

- Improve the accuracy of forecasting and sales pipeline reports. Allow resellers to view and update their sales opportunities through the partner portal, and add new opportunities, including probability of close numbers and related sales strategies;
- Make informed decision about competitive position, pricing strategies and sales techniques by gathering customer feedback from partners;
- Review opportunities by account manager or partner to effectively manage and motivate partners sales;
- Reduce the amount of time needed to resolve post-sales questions and issues, and build stronger relationships with end customers. The partners can create new customer service cases, view cases in progress, and modify specific sections of existing ones to keep everyone up-to-date;
- Automatically notify partners about the status of cases in progress, case resolutions, or specific related actions and events.

Key Resources & Key Activities

Here, we present a concise set of key resources available at each entity and the major activities that shall be performed by these entities.

1. Network Operator/Portal Provider

- Technical competences in the fields of management and marketing;
- Brand image and reputation;
- Partnership with resellers or agents;
- Establishment of a direct relationship with customers;

The Network Operator/Portal Provider is responsible for the establishment and execution of the sales component. To perform this task the Network Operator shall establish a management communication channel between them and their resellers, distributors and retailers. The Network Operator is also responsible to implement marketing campaigns for the customers.

2. Open Source System Integrator

- Personalization of solutions;
- Knowledge of Open Source and commercial solutions;
- Knowledge of several network and IT applications;
- Deep knowledge of open standards protocols;
- Focus in the usability component.

The Open Source System Integrator is responsible to provide “best-of-breed” solutions for the Network Operator. The Unified Communications solution can accomplish OS and proprietary technologies.

3. Open Source Support Services Provider

- Specialized technical competences;
- Post-sale service;
- Specialized resources in the security field;
- Internal R&D team;

The Open Source Support Service Provider is responsible to develop specific Open Source solutions and provide support services for OS solutions.

4. Open Source Provider

- Scientific and technical competences background;
- R&D projects and motivation to be involved in such kind of projects with a strong research component;

The Open Source Provider is responsible to develop Open Source projects in cooperation with other developers around the world.

5. Legal Support Provider

- Knowledge of legislation and strong competences to understand the Open Source licenses;

The Legal Support Provider is responsible for juridical consultancy.

6. Quality Certification

- Competences in the domains of quality management;
- Independence and impartiality behaviour;

The Quality Certification is responsible to make tests and evaluate the software provided by the Open Source System Integrator entity.

7. Training Providers

- Certification of competences of their employees;
- Regular internal formation of their employees;
- Knowledge of major networking office needs;

The Training Providers entity is responsible for the formation of human resources at the Open Source System Integrator role and at Customer role.

8. Open Source Consultant

- Experience of their employees;
- Flexibility and adaptation capacity of their human resources;
- Targeting of several markets, not only the telecommunications domain;

The Open Source Consultant is responsible to provide consultancy services attending to the “best-of-breed” technical solutions available in the Open Source market and working methodologies.

Revenue Streams & Cost Structure

Here, we present the most relevant revenues and expenses for each entity following the proposed model in this scenario.

The most important source of revenues of this scenario is the sales of the Unified Communications solution. Typically, a Network Operator can provide a multi-function network device that offers a full network infrastructure for enterprise branch offices with additional managed security services or a Network Management Service (NMS) that offers a secure architecture for proactive remote networking and management. Also, it can offer a package of services to remotely diagnose and repair problems in a network or a subscription-based to access a collaborative and remote CMS platform. Besides that, a Network Operator can offer a package of new add-ons to support the integration with other office IT applications, such as ERP and CRM applications.

Another important revenue is the support services provided by the Open Source Support Service Provider. This entity can play a very important role in the overall solution offered by the Network Operator, because it can provide additional security and reliable solutions.

On the other hand, the most relevant expenses of this scenario are the high-technical human resources needed by the Network Operator, Open Source System Integrator and Open Source Support Service Provider entities. Besides that, the Open Source System Integrator will have some expenses to mount and assemble the hardware equipment of the Unified Communications device and can spend some amount of money in the licensing process of eventual proprietary technologies that can be used in the Unified Communications system. At the same time, the Network Operator will need a good technical infrastructure to provide the requested support network services to its customers.

In table 8 we show the major revenue streams and cost structure for the entities of this scenario.

Table 8: Major revenue streams & cost structure of scenario I

Network Operator	
Revenue Streams	Cost Structure
Selling Unified Communications device directly to the customer	Human resources
Add-ons to support integration with office applications, such as ERP and CRM	Technical IT infrastructure
Support services access to the platform	Hardware equipment of the Unified Communications device
	Paid services to other entities in the “model”
Open Source System Integrator	
Revenue Streams	Cost Structure

Creation of Value with OS Software in the Telecommunications Field

Selling the Unified Communications platform to the Network Operator	Human resources
	Paid licenses to include proprietary software
Open Source Support Service Provider	
Revenue Streams	Cost Structure
Selling support services	Human Resources
	Services paid to other entities
Open Source Provider	
Revenue Streams	Cost Structure
Knowledge and status inside the OS project	Consumption of time and effort
New career opportunities	Some minor technical infrastructure (can also be considered redundant)
Legal Support Provider	
Revenue Streams	Cost Structure
Consultant services	Human resources
Quality Certification	
Revenue Streams	Cost Structure
Based in the certification's type	Human resources
	Certified fees (e.g., RedHat formation)
Training Providers	
Revenue Streams	Cost Structure
Based in each formation provided to the customers	Human resources
Established contracts with Network Operators and Customers	Technical material
	Investments in continuous formation
Open Source Consultant	
Revenue Streams	Cost Structure
Consultant services	Human resources

Partner Network

Nowadays, business models are more and more a result of partnerships, joint ventures, cooperation and alliances between different companies to bring specialist competences that can't be easily offered by the company.

In this scenario, the importance of partner network is very well established to bring value to the product offered to the client. Training Providers, Open Source Providers, Legal Support Providers, Open Source Support Service Providers and Open Source Consultant can be partners of the Network Operator in all this process. A dynamic Network Operator have to find the right information at the right time in order to survive and succeed. However, often their resources for research and development projects are quite limited and using traditional consultancy might be too expensive. Network Operators have to find new ways to conduct research to maintain their business competence.

A solution for this issue is to use the universities/research centres as consultancy entities that provide knowledge and technical competences for Open Source solutions. However, traditional visions of universities describe them as old and powerful institutions and their traditions are just as strong. In addition, the universities have been somewhat isolated from the outside world serving the purpose of science and academia (Tommila, 2005).

Although, along with the development of the knowledge society, the importance of universities and research centres as knowledge producers has grown to a new level and the potential of academic research has been noticed. Universities have founded, in cooperation with other private and public actors, many different intermediating organizations that focus on supporting the information transfer, commercialization and creation of innovative research based business.

The government has also an important role in this process. For the government, the possibilities of a fruitful cooperation seem obvious because businesses are looking for valid and reliable information and knowledge and the universities are under pressure to interact with the society. Many actions have been taken to increase cooperation and especially the initiatives of the European Union (EU) are unique in their efforts to bring sectors of business, university and government together. Since the Lisbon initiative in 2000 and the start of the eEurope program in 2001, EU has been pursuing an ambitious objective to bring Europe to the era referred to as "Knowledge Society" as number one in the world.

A strategic alliance between Business, University and Government will bring the following advantages:

- Rising global competitiveness – rapid change in the nature of competition has created increasing demands on companies to develop new technologies;
- Increasing need for innovation in products and processes – the new technologies do not create themselves and neither are they all developed from the existing ones. Inter-organizational methods are used to create them and also the non-business systems can be used to stimulate innovation more effectively;

- Lower R&D expenditure – attending to the study conducted by George, Zahra & Wood, companies with university linkages have lower research and development expenses per employee. In addition, these businesses might develop the relationships even further to supplement their internal research resources;
- Technological transfer opportunities – an especially important factor in the business-university partnership is the technology transfer issue.

7.4.2.3 Model Assessment

In a first instance to assess the viability of the application of the proposed framework to this scenario we will conduct a SWOT analysis.

Strengths

- High number of OS applications – the number of OS applications available in the market in the fields of networking, storage, VoIP, security and multimedia is really very huge. As an example, SourceForge has more than 130,000 registered Open Source products and more than 1.4 million registered users (SourceForge.net, 2007). This web site is responsible to provide an open-source repository, Open Source development tools and host Open Source development projects;
- Lower costs of development process – Open Source software typically has lower acquisition costs than commercial software solutions. Some more advanced Open Source components, like replication and fault-tolerance functions, cost money and require a certain level of technical skill. However, the majority of the Open Source users do not have the need for such advanced features and functions. Besides that, the Open Source System Integrator has always the possibility to use only OS software directly from the community of developers and adapt it according to the specific requirements of the Unified Communications system;
- Security of solutions – generally, Open Sources solutions can be considered more secure, because the source code can be accessed by many experts that can expose the vulnerabilities of the code. Besides that, and comparing with proprietary source code, keeping vulnerabilities secret doesn't make them go away, but can potentiate the attacks and increase the risks of them. Therefore, a Unified Communications that supports an open architecture can take important benefits from those OS applications;
- Possibilities to customize – using a modular open architecture, the Unified Communications solution can be easily customized and new improvements can be made;
- Innovative device – we propose to create a single all-in-one application that will support a wide range of functionalities in terms of networking and communications, that will lead to the implementation of the concept of Unified Communications;
- Good relationship between quality and price – the price of the device will be significantly lower than the price to buy all these applications separately. At the same

time, we get another important advantage in terms of communication and integration between different applications;

- Low barriers to entry – using this framework, a company operating in the Open Source market can easily become an Open Source Support Service Provider or a Open Source System Integrator.

Weaknesses

- Dependence from several entities – there are several players in the market and the complexity of coordination between them can be huge;
- Complexity of licensing – one important and very discussed point in the Open Source community is the integration between Open Source and Closed Source solutions. There is a “no recipe” that works well for all scenarios and this integration need to be analyzed taking into account the Open Source licenses and its availability to be used with Closed Source solutions;
- Culture resistance – Traditionally the Telecom market is dominated by software companies that already made huge investments with incumbent software companies that use Closed Source software. These companies can have resistance to change its business model and to put in risk some of their revenue;
- Lack of consulting expertise in OS – there are a lot of consulting companies operating in the Telecom and software market. But the situation is totally opposite in the Open Source market;
- Cost of internationalization – we propose to develop a Unified Communications solution that addresses the worldwide market. However, to implement this strategy we will need to define an international strategy that will contain mandatory costs of exportation of the solution to other international countries.

Opportunities

- Attractiveness for the participation of Universities and R&D centres – universities and R&D centres can participate in the Open Source projects being an Open Source Consultant;
- Influx of start-up companies – the number of start-up companies have been increasing significantly during the last years. Start-up companies represent an opportunity for Open Source solutions because they typically cannot afford a large in-house development staff;
- Improvements in Internet connectivity – the number and productivity of Open Source development teams expand with the Internet. The technology of the Internet enables Open Source development and support to continue 24 hours a day, 7 days a week around the world. The growth of the Internet will continue to expand Open Source

software by making it accessible to a larger number of people. Collaborative technologies, such as e-mail lists, newsgroups and websites have fostered the growth of open source;

- General business trends – the recent adoption of Open Source solutions by the government and the involvement of big private companies in the Open Source market increases the credibility and acceptance of these kind of solutions;
- Market dimension – we intend to address the SMB international market. The SMB market is a large market to target, which produces about 50% of the revenues in the UK/US. Analysis forecasts that total revenue from value-added services, including firewalls, virus protection, email, Web hosting, VPNs, VoIP services, storage solutions, managed LAN servers and managed Windows desktops, will grow from €1.1 billion in 2003 to €10.3 billion in 2008 (www.analysis.com, 2007);
- SMBs tendency to buy value-added solutions – SMBs in most developed markets have the tendency to buy value-added network and communications solutions. They look essentially to new single-one applications that can manage different network applications and that can be easily configured and managed (Arnold and Kehoe, 2008).

Threats

- Risk of fragmentation of OS projects – this scenario covers the introduction in the market of an Unified Communications device that uses several OS applications. The Network Operator and the Open Source System Integrator don't control entirely the target path of these projects, even when they participate entirely in them, which can lead to different vision of the future of these projects. This can lead to a scenario of fragmentation. Fragmentation of the code base, or code forking, occurs when multiple, inconsistent version of the project's code base evolve. This can occur when developers try to create alternative means for their code to play a more significant role than achieved in the base product;
- Increasing hardware complexity – as hardware becomes more advanced, it becomes more and more complex. Each new generation of processors and peripherals only builds on the complexity of those that came before. Often new hardware is poorly documented or not documented at all, as hardware manufacturers believe that the inner workings of their hardware is an important intellectual property. Nowadays, we assist to a small amount of advanced software and graphic cards that are only supported in Open Source systems by binary only closed drivers.
- Strong incumbent competitors - there is a high number of incumbent competitors in the market. They typically address big enterprises, but if this market segmentation starts to decrease, the SMB market can be a good alternative for them. They can also develop a proprietary Unified Communications solution that can be integrated with their proprietary platforms;
- Different market legislation – there is different legislation between several markets which complicates the product exportation.

Attending to the Osterwalder model, we will consider some pertinent questions that should be formulated to some building blocks of the proposed business model for the Unified Communications solution, in order to assess it.

The first question tries to get a clear vision of the value proposition of unified services. This is one crucial aspect in this scenario, because the delivering of a single unified communications device introduces a new concept in the market. The customer shall realize entirely the benefits of this approach comparing to the traditional vision of having a different device from several vendors that manage some components of the network and communications system.

The second question looks to the relationship with the customer and vendors of the network and unified communications solution, attending to the communication and distribution channel implemented by the Network Operator. We will describe how a start-up company can take advantage of the viral marketing approach to reach a large community of potential customers with minimal financial expenses.

In the third question we will analyze the relationship between Network Operator and its partners and supplier. We will give a special attention to the relationship between the Network Operator and the Open Source Provider entities in terms of collaboration and support for new developers. In addition, we will introduce the possibility of using universities/research centres as consultancy entities in the fields of research/innovation, professional development and recruitment.

1. Do customers perceive the value proposition of Unified Communications?

This is always a big issue for any company. To be able to analyze this situation, we must realize which components of our value propositions are really crucial to attend the customer's needs. Attending to the feedback received in the case studies analyzed in this research work, we admit the following five crucial requirements that must be attended:

- Simplified deployment and management – it must simplify the IT infrastructure management;
- Higher productivity and convenience – it must improve customer service by using enterprise-grade voice, data, and IT and it must improve the control over the use of IT by employees;
- Significant cost savings (Capex and Opex) – it must offer important savings in initial capital purchase, installation and test timing, troubleshooting and security protection;
- Service Level Agreements (SLA) and ability to provide uninterrupted services – it must validate expectations of the respective parties and set parameters for measuring project success. It must help the customer to meet or surpass business and technology service levels, which in turn leads to increased productivity and flexibility, and improved standardization and capacity. The full attendance of this requirement is especially important in the business market. The Critical Links and iPortalMais offer a SLA

service to their customers, but their implementation is a little different. Both companies follow a three-tier support based in their resellers, distributors and manufacturers. However, Critical Links offers an internal support based in a traditional helpdesk, technical support attendance and remote diagnosis. The iPortalMais also offers the possibility to have a direct support, but its emphasis is in the formation of resellers to let them, as soon as possible, perform this task independently. iPortalMais doesn't have a so organized technical support, but the degree of cooperation between the company and resellers is bigger than Critical Links;

- Technical expertise – most customers do not have in-house expertise or resource pool to handle migrations to technologies requested in the proposal. The ability to provide this expertise and the ability for a customer to get these resources from a single place is another crucial point for the success of a implemented solution.

On the same way, the customer must realize the major advantages provided by the use of Open Source solutions. One of the most important advantages is that customers can rapidly assemble custom solutions with FOSS. This let a Network Operator/Open Source System Integrator build a specific business solution to improve business rather than forcing one's business process into a vendor's process or pricing structure. At the same time, the use of open standards encourages and enables multiple implementations, regardless of the development forum, and benefits the customer.

2. Does Network Operator have a well through-through communication and distribution channel design along the proposed value-chain?

The communication and distribution channels presented in this scenario are based in the potentiality of new Internet technologies and in the concept of viral marketing.

We consider that we can take advantage of the following channels:

- Chat – for real time communication, short questions and coordination;
- Mailing lists – to stay updated with the latest improvements and news;
- Forums – to communicate with community members in order to discuss features, configuration and installation issues;
- Call centers – to attend specific questions and doubts from the customers.

One of the privileged channels to a Network Operator contact with the customer is using a Call Center infrastructure. They are intended to provide orderly cost efficient telephone-based services. They serve as the primary telephone interface with customers for specific services provided by the agencies. The call centers have structured environments where calls are handled by a group of skilled professionals who provide the service required by the caller or transfer the call to someone designated for that purpose. One of the key issues using a Call Center is the importance for a organization to monitor and analyze the performance of their call centers to ensure that the benefits are realized at a reasonable cost to them. Each call to a call center is a “moment-of-truth” for a customer's perception of the agency. The impressions made by a call center on a customer are a significant contributor to whether benefits are delivered at reasonable cost to agencies.

One very successful communication channel used by start-up companies in their commercial strategy is the viral marketing concept. Start-up companies see viral marketing as the opportunity to get the most coverage with the least amount of capital. Initiating a viral marketing campaign requires insight into the mechanics of viral marketing and well planned strategies. In order to a marketing concept to be viral it must fulfil certain criteria. Foremost, it must be initiated by the customer on his own free will. The idea is not to have a customer do the advertising against payment and, more than that, to do something which he would normally not do.

Viral marketing has the opportunity to reach thousands of potential customers at minimal expenditure. The instruments or tools for spreading viral marketing campaigns in the Internet are the people who visit the Web. Their desire to communicate with others is an asset for marketers, the message spreads exponentially, but only if the service or product contains certain qualities.

Skrob considers some elements, shown in figure 63, that stimulate the word of mouth strategy (Skrob, 2005):

Figure 63: Instruments that stimulate the “word of mouth” concept



Source: Skrob, 2005

Attending to figure 63, we can realize that the Open Source market already offer some of these tools to begin a viral marketing strategy, namely chatrooms, newsletters and a strong support community.

Using the viral marketing concept we can formulate a viral marketing mix, with the following particularities of its fours “P’s”:

- Product – certain products are better suited for viral marketing than others. Computer software and networked/communications services are usually very-suitable to be provided over the Internet;
- Price – one strategy to catch the attention of customers viral marketing is to give away products or services. Customers react positively if a product is less expensive or on an item that is on sale, however, the word “free” attracts “eyeballs”. Usually, this strategy comprises two steps. In a first step free software can be downloaded which in turn encourages the customer to pass the news on to others. The second step involves generating revenue with complementary service, such as updates or premium products;
- Place – viral marketing takes place on the Internet and where contacts and trade takes place in the virtual marketplace;
- Promotion – in viral marketing the customers plays a leading role in promoting a product or service and, at the same time, winning new customers for the product or service. The promoting is done by offering something the user finds useful.

The viral marketing concept and the use of this concept associated with Open Source project bring great opportunities. However, the highly connected net of consumers can have undesirable side effects if the product does not reach their expectations. A network of unhappy customers can have a negative effect on word of mouth. The probability that satisfied customers pass on the message is equally as intense as the spreading of negative propaganda for dissatisfied customers.

Customers articulate their dissatisfaction over a product or service with the Internet, influencing their immediate social contacts as well as the loose associations. The personal experience is authentic and there is no personal gain involved which makes the voiced discontent credible. This negative word of mouth propaganda reaches thousands of potential customers in a very short time, endangering corporate image and the success of a marketing campaign.

iPortalMais was one the companies that took advantage of this model. Attending to Raúl Oliveira, the company never had a strong focus in the market and the need to look for new clients based in an aggressive market campaign. Initially, it was their clients that requested their services and the successful implementation of IPBrick.IC and IPBrick.GT solutions opened the doors of new customers.

3. How dependent is the proposed model from the existing partners and suppliers?

Looking to the diagram scenario presented in this section, we can consider all these entities as partners. However, some of these partners can be looked as suppliers, namely the Open Source Support Service Provider and especially the Open Source Provider entity. This last entity is a critical supplier in our model and it is the gene of the products offered by the Network Operator. Therefore, we need to give a special attention to the relationship between the Network Operator and the Open Source Provider entities in terms of collaboration and support for new developers.

The software development can be considered a closely-coupled activity, often with tight integration and interdependencies between modules and, therefore, requires a substantial amount of coordination and communication between developers, if they are to collaborate on features. Geographically distributed collaborative work, on the other hand, tends to result in significantly reduced communication between team members. Therefore, one of the biggest needs in distance collaboration is more awareness of the activities of developers at remote sites. The lack of awareness stems both from reduced communication and from missing contextual information, which is naturally and implicitly shared in co-located contexts, but is difficult to obtain in distributed work.

One special partner that has to be considered in this scenario is universities/research centres acting as consultancy entities. In this situation, an organization can profit from the experience, research and innovation provided by universities. This partnership can be concretized in the following three domains:

- Research and innovation – it can be possible to access research expertise and add value to the business of the organization;
- Professional development – it can be offered training, short courses and customized corporate program. In this situation, the University/R&D Centre can act as a Training Provider;
- Recruitment – it can be used to attract high qualified students and graduates to the company.

The proposed scenario is not so dependent from Open Source Consultant like it is from the Open Source Provider. However, the quality of the product and the amount of value-added services offered to the consumer are dependent of the collaboration between the Network Operator and the Open Source Consultant, especially when this role is performed by an University or R&D Centre.

7.4.2.4 Model Innovation and Improvement

Attending to the Osterwalder model, we will consider some key questions that entities of the proposed framework can formulate to innovate and improve their current positioning and strategy.

The first question will intend to find an approach to increase the revenue of a Network Operator. Initially, in this scenario, we considered that the Network Operator would only get revenue from the sales and support services of the Unified Communications solution. However, in several situations, the Network Operator can extend its role and act as a Manager Service Provider (MSP) to offer remotely managed IT services to other companies. These companies can be already clients of the Unified Communications solution or can be companies that use several different components to manage their internal network and communication systems. In this situation, these companies can also adopt a strategy to slowly migrate their internal network and communication systems to a single one Unified Communications device.

In the second question we will look to a way to better integrate and use new communications channels that can be used to complement the typical communications channels considered to implement the concept of viral marketing. We will explain how companies can take advantage of corporate blogs, wikis and podcasts to improve the relationship with customers and to get feedback from them.

In the third question we will analyze what is the best approach to penetrate the international market for a company that offers an Unified Communications solution. We will consider the possibility to use distributors, traditional resellers and value-added resellers. Finally, we will analyze the option to use only a web channel as distribution channel. We will compare these approaches and establish the situation they suit better.

In the fourth question we will try to prove that the practical concept of open innovation can be easier exploited when the Network Operator uses Open Source technologies and open standards. The intention is to include Open Source software as part of corporate open innovation and use OSS to fill the gap between innovation and product. The SMEs companies could use this approach to create value in their target market.

1. Could Network Operator introduce new revenue streams?

The Network Operator can get additional revenue from the Unified Communications solution giving more attention to the services revenue component. The Network Operator has conditions to act also as a Managed Service Provider (MSP) receiving incomes from services typically on a monthly basis.

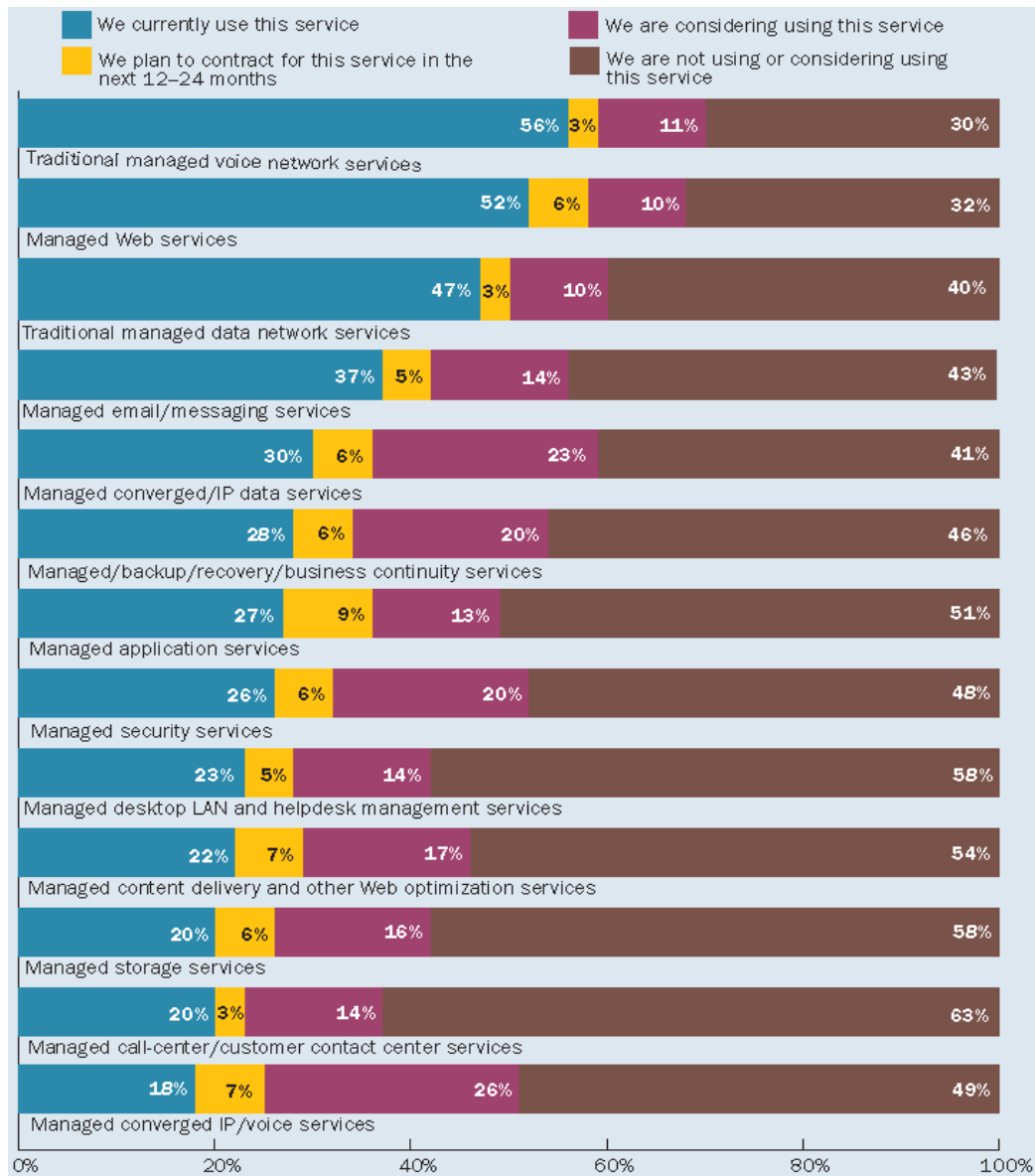
A Managed Service Provider (MSP) is a company that manages remotely IT services for other companies: it offers continuous outsourcing of an IT function; it works on a recurring revenue model, monitoring and fixing things proactively, doing these tasks remotely, rather than having to work hands-on at a client's office. Common services provided by MSPs include remote network, desktop and security monitoring, patch management and remote data backup, as well as technical assistance.

At the present time, managed services are getting increased attention as more focused offerings and flexible pricing arrangements become available. The “out-tasking” approach of offloading specific aspects of IT/communication management has taken hold over the past several years, displacing the former paradigm of outsourcing entire departments or service classes. Today's managed services aim to optimize the performance of IT/communications operations with shorter and more flexible service contracts. At the same time, Service Providers intent to move from increasingly commoditized services to value-added converged IT, voice and data managed services. Companies prefer to have a single telecom-office application and to deal with a single partner for ICT issues than with a multitude and optimize procurement and supplier management costs.

In 2006, the Thinkstrategies.com consulting firm company conducted a study to analyze the adoption of managed services by companies. They received about 550 usable responses from

small, medium and large companies across all industry segments, as well as non-profit organizations and governmental agencies. The results are depicted in figure 64.

Figure 64: Adoption of managed IT/Network services



Source: Kaplan, 2006

Comparing this study, in the year of 2006, with the same study conducted in 2003, 40 percent of the companies said they are using one or more managed services, compared to 35 percent in 2003. The highest percentage of survey responses reported using traditional voice network services (56 percent), followed by managed Web hosting (52 percent) and traditional managed data services (such as managed frame relay and ATM networks, 47 percent).

Others surveys about the use of managed services by companies are available on annex P.

The surveys conducted by BCR and thinkingstrategies.com clearly indicates that while managed services have gained solid market acceptance and generated reasonable customer

satisfaction, Managed Service Providers (MSPs) have significant work to do to build greater momentum, market penetration and customer loyalty (Kaplan, 2006).

In order to capitalize on new market opportunities, the emerging and established MSPs must take a closer look at the difference in attitudes and preferences between corporate/business unit managers and IT/network professionals. They should also re-examine their market segmentation strategies to leverage growing acceptance of managed services among large-scale enterprises, and confront lingering resistance among SMBs. At the same time, MSP must do a better job of delivering higher-quality services which generate stronger customer satisfaction and loyalty. As the managed services market become more competitive, MSPs will need to offer services which encourages their customers to renew and expand their subscriptions, and serve as referral agents for their providers. The implementation of this strategy can usually lead to a cross-selling policy.

The cross-selling strategy is particularly suitable when the users want to purchase multiple products or services from the same provider, having one single contact. This scenario can be considered for a MSP provider, especially with the increasing market competition, that let MSP focus more attention on customer acquisition. Chaohua defends that the cost of winning a new customer is five times that of retaining and old customer, and the profit achieved by winning over 10 new customers cannot offset the expense of losing a valuable customer (Chaohua, 2007). Besides that, there are many other benefits of a cross-selling approach, including:

- Strengthening the relationship with the enterprise' clients by broadening the range of services they utilize;
- Lifting practice profitability by making clients aware of the full range of services available to them;
- Allowing the company to leverage different skill sets within the firm and open up a mix of career paths for the internal staff team.

It is expected that the managed services market will increase largely during the next years. Ovum, a consulting firm that specialized in telecom and software consulting, released a study in May of 2008, projecting that the global market for managed services will deliver revenues of \$66 billion by 2012. The study, which collected data from more than 1300 enterprises managed services users in 14 countries, projects that managed IP-based services will see a compound annual growth rate of 18% over the next four years. Overall, the study finds that the managed services generating the most interest among corporate users are managed metro Ethernet, managed IP, VPNs, managed VoIP and managed security (Reed, 2008).

2. Can new communication channels be used and integrated?

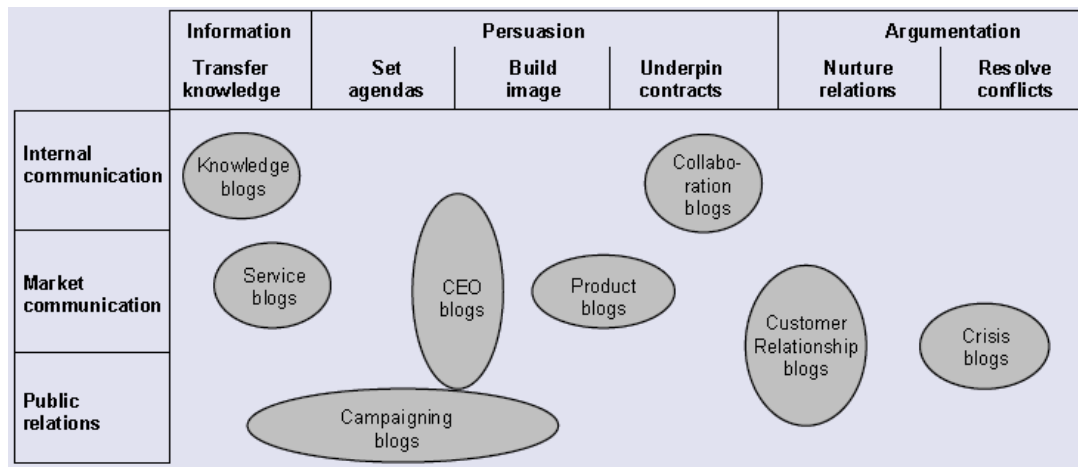
In the previous section we considered some typical communication channels that can be used to deploy the concept of viral marketing. Among them, it was considered the chat rooms, mailing lists, forums and call centers technologies. However, the pace of technology is very

high and there are always appearing new IT communication technologies in the market, namely blogs, wikis and podcasts.

A weblog or blog is a website in the form of a diary with pithy, frequented updated entries that are posted regularly. Additionally, they often contain links to other websites and blogs so the reader can quickly find blocks of news, information and opinions on a specific topic. A blog can be kept by an individual or by a group of people. The communication form represented by blogs is, fundamentally, nothing new. But unlike chatrooms or newsgroups, blogs are showing booming growth rates and are in the process of becoming a mass medium. Visitors to a blog are usually given the chance to comment in individual postings. A function called trackback enables blogs to exchange information with each other about responses and comments through an automatic notification system.

Here, we show a brief overview about the deployment possibilities for corporate blogs.

Figure 65: Deployment possibilities for corporate blogs



Source: Heng, 2005

For corporate communication management, blogs fall into three different levels of significance:

- The blogosphere offers a new communications arena and can influence public opinion on the company;
- Customers, experts (e.g., software developers) and adepts of certain products are among those who seek publicity as bloggers. Company employees also use private blogs and may possibly put in them opinions on company-specific issues;
- Companies can use blogs as an internal communication tool, e.g., for dialogue between board members and company employees. Via internal blogs the responsible parties can respond rapidly, pointedly and appropriately to relevant topics.

External blogs are participatory communications tools that can build complex and effective networks. Blogs build connections and links between and among the key audiences, which help the corporations use these networks over time to persuade people on action, to respond to a crisis, to leverage market conversations and to improve the business overall.

The business blog can provide additional value by adding a level of credibility that is often unobtainable from a standard corporate site. The informality and increased timeliness of information posted to blogs assists in increasing transparency and accessibility of the corporate image. Business blogs can interact with a target market on a more personal level while building link credibility that can ultimately be tied back to the corporate site.

Wikis, first popularized by Wikipedia, are interactive Web sites that allow multiple writers and editors to produce and distribute content collaboratively. Wiki software automatically tracks revisions and changes, providing a convenient audit trail, and the ability to revert back to previous versions.

Wikis are cheap, extensible, and easy to implement, and they don't require a massive software rollout. They also interface well with existing network infrastructures. Furthermore, wikis are Web-based and thus present little or no learning curve in the adoption cycle, and they allow the user to determine the relevancy of content rather than being dependent upon a central distribution center or a linear distribution chain. After the initial setup, users, not administrators, control a wiki, to the benefit of all.

A major benefit of many wikis is their ability to organize themselves organically. In other words, users can create their own site structure, or ontology, rather than have it imposed on them by the developers of content management software. Wikis need to be used by people with a shared cultural language so that the ontology and navigation make sense to everybody. Wikis are well-suited to the workplace because a common corporate language is already present. Finally, it is the inherently collaborative nature of wikis, as opposed to the workflow structure of content management software, which distinguishes wikis and gives them the upper hand. A traditional project management tool simply cannot reproduce the environment of collaboration and involvement that wikis create.

It's not surprising that the Open Source movement has been especially aggressive in adopting wikis as a means of coordinating distant contributors. Various Open Source projects, such as the Ubuntu distribution of Linux, use wikis for both documentation and collaboration.

A podcast can be loosely defined as an audio file that is enclosed into an RSS 2.0 feed. More specifically, it can be seen as an audio file (mp3 format) that is presented in an RSS feed.

Podcasting can also be implemented with audio and video files. Podcasting is in its relative infancy but is growing at an astronomical rate. What makes podcasting a unique marketing and communication tool is that it allows individuals (or businesses) to publish audio and video shows that interested viewers can subscribe via RSS. Before podcasting, it was, of course, possible to record an audio/video show and put it on a website, but now people can automatically receive new shows, without having to go to a specific site and download it from the website.

In table 9, we can see a concise list of potential uses and benefits of podcasting technology.

Table 9: Potential scenarios of the uses and benefits of podcasting

Potential Uses of Podcasting	Potential Benefits
Building of Brand	Increased visibility, through leader positioning in the marketplace. Increased visibility & awareness of products, company or service. Extend the brand further in this new media format.
Industry News & Insights	Latest updates about industry or interviews with leaders in market niche. Increased visibility, through leader positioning in the marketplace. Increased visibility & awareness of products, company or service. Brand is extended in the industry.
Customer Loyalty	Keep your customers informed, updated, and aware of information that is of value to them. Increased loyalty, customer satisfaction and profits are 3 of the end results. Increased visibility, through leader positioning in the marketplace. Increased satisfaction of existing customer base & improved awareness of your products at the customer's eyes.
Public Relations	Product development news and announcements. Keep the target market informed of what is being developed, or trends in the industry. Get the word out to the media and differentiate your products and services. Increased Press visibility and media coverage.
Increased Market Messaging Reach	Reach markets and an audience that is not reachable from other media formats. Increased visibility, through leader positioning in the marketplace. Increased visibility & awareness of your products, company or service.
Company News	Podcasting of meetings, news and company updates to remote, virtual and local employees. Improved communication to employees and business partners. Continuity of management messaging.

Source: Rumford, 2005

Another important aspect to attend is the integration of these new IT technologies with the Information Systems of the company (intranet and extranet). This integration can be seen in three different components:

- Integrated functionality – effective communication combines the primary processes of notification (getting the message out), responsiveness (providing answers to questions

and concerns) and engagement (gathering feedback from stakeholders). An integrated system should address all of these in a manner where the interrelationships between these activities can be leveraged to achieve communication objectives;

- Integrated user interface – the administrative functions of an integrated system should be accessible from a single interface, rather than requiring logins to different sites or through separate pages;
- Integrated user list – there should be a single user list (rather than user lists) for each different functional module or application.

The benefits of an integrated strategy tend to cluster on the following categories:

- Cost savings – in general, the more features we get in a software product, the less the average cost per feature. Buying individual applications generally adds up to more cost than an integrated suite of applications. This is particularly true when we add the cost of hardware, IT staff time, data importing and exporting, and a long list of other costs that go into the Total Cost of Ownership (TCO) of software;
- Staff Training/Learning Curve – the more applications the company's staff has to learn, the more time it takes for them to become proficient in any one application, and the longer it takes to become proficient in all of them. With an integrated system, all the functional modules are combined and accessible through a single user interface, saving on time to climb the learning curve of the application;
- Data Administration – Most IT directors know that managing the same data in multiple places is a recipe for out-of-date information. With standalone applications, each application must keep a copy of a user's email address and other contact information needed to communicate with that user. If this information changes it has to be updated several times, in several places. With a consolidated user profile there is one location to update information, and the user is able to make changes to their profile online and on their own.

3. Which partners could help Network Operator to complement its value proposition in international markets?

One very important partner that can be considered when a company wants to launch a product in the international market is to use a reseller or a distributor. International markets represent an exciting growth opportunity for technology companies to expand their business with fewer resources and to open up new geographical areas of business.

Distributors are commonly used when the product has such a large potential market of end users that the vendor does not want to support numerous resellers directly. Generally, distributors will expect at least a 50% margin plus additional funds to help in the marketing and promotion of a product (York Group, 2008). Distributors will usually not take on a product unless:

- There is a significant existing or potential market;

- Resellers are already aware of the technology and have a desire to buy;
- The product offers features that substantially differentiate it from competition;
- There is an effective marketing program in place;
- The vendor is able to provide technical support, training and merchandising tools.

The difference between resellers and Value-Added Resellers (VARs) is based primarily on the level of services provided with a sale. Resellers tend to be product-oriented, and VARs tend to be solutions-oriented. Resellers are expected to market specific products, be they hardware or software, while VARs will include those products in an overall solution that they are selling to their clients.

Critical Links uses a strategy based in VARs to penetrate the international market. In a first instance, and to identify potential interesting partners, the company shows its products at international fairs. This is really a very successful approach according to Eng. João Belo from Critical Links. Recently, this company signed a partnership agreement with VanCost Systems (a leader in providing enterprise-level technology to SMB in the Atlanta metropolitan area) to let the edgeBOX product become available to VanCost Systems' customers who support remote workers, remote offices or telecommuting enhanced capabilities. Terry Van, CEO of VanCost Systems, explains that VanCost Systems will be working with Critical Links to deliver its cutting edge technology to their small to medium-sized business customers proving a remote office/remote worker solution. (Taveira, 2008).

For most products, reseller training (sales and technical) should be mandatory, for many reasons:

- This guarantees that the reseller will have the product and marketing knowledge he will need to successfully sell and support the product in his market. The product knowledge that he will achieve by installing it on his own machine and playing with it is limited compared to what he will learn by spending time with the internal staff of the vendor's company. The reseller will discover different features and functions that will make it easier to sell the product, and he will be in a better position to provide the right level of technical support;
- It is a good screening process to ensure that the reseller is serious about marketing the product. The cost of the trip and the opportunity cost of the time he is spending away from the office represents an investment by the reseller, and he will want to recover those costs by selling the product;
- Improve communication. The reseller will personally know the contact people in the vendor's company that he can call or e-mail to resolve specific problems which will result in a stronger relationship between the vendor and the reseller;

Another possibility to sell products abroad is to use a Web channel. This is particularly recommended to get started for certain types of products, especially if the product is relatively inexpensive and can be installed out of the box. However, it is necessary to have the right procedures in place before taking orders. Some of the issues that have to be addressed include:

- Shipping – Every country has different taxes, tariffs, import restrictions that have to be considered. It is usually advisable to work with established international shipping companies, which know the customs regulations of every country, and in many cases have their own offices with the local customs agents;
- Value-added taxes – Tariffs and taxes could be applied even when we are distributing our products electronically;
- Getting paid – the easiest form of payment is by credit card or Paypal. There are, however, some drawbacks for using credit cards as the primary source of payment. For one thing, many people don't like to use credit cards, so a large percentage of the market will be unable to pay you, even if they want to order. A second risk to be considered is the credit card fraud;
- Marketing – It's important to create awareness and drive traffic to the website of the company. This can be done through search engine optimization, banner advertising, product reviews in trade publications, links to high volume websites and blogs, etc.

Previously, we identified the kind of partners that could help the Network Operator to penetrate in international markets. Now, we present a methodology to help a Network Operator to evaluate the value of these partners. The Network Operator should identify and evaluate the partner value network. This evaluation should be proactive rather than more or less reactive, as it is in many companies. The evaluation should be carried out on the basis of value-network identification and the company's general strategy.

The typical phases in the partner-management process are presented in Table 10.

Table 10: Phases in the partner-management process

Phase	Issues included	Estimated duration
1. First contact	- Filling in of partner application form - Collection of background information - Information given about validation criteria	1 week
2. Early negotiation	- Business review (analysis of products and competence) - Partner assessment and presentation of partner program	3 weeks
3. Analysis of the potential partner	- Filling in of the partner analysis form	2 weeks
4. Second-stage negotiations	- Visit by the potential partner - Preparation of the business plan	4 weeks

5. Signing of the Contract	- Draft contract	1 week
6. Early phases of the partnership	- Establishment of partner folder, early information collection - Discussion and analysis of training issues - Agreement on partner-monitoring criteria	1 week
7. Training	- Participation of partner's personnel in training academy	4 weeks
8. Consultant gives further training	- In-house consultation for the new partner	2 weeks
9. Pilot case	- First customer	2 weeks
10. Normal operations	- Dealing with some minor issues	8 weeks
11. Review	- Partner meetings and assessments - Further development of marketing plans	2 weeks

Source: Varis, Kuivalainen and Saarenketo, 2005

The fit of the potential partner is evaluated on four dimensions:

1. Business potential;
2. Customer segment fit;
3. Product and service fit;
4. Marketing and sales fit.

These dimensions are presented in more detail in table 11.

Table 11: Partner fit evaluation criteria

Evaluation criteria	Relative importance
Business potential	
1. Strategic importance	High
2. Business potential	High
3. Short and mid-term revenue	Medium
4. Partner commitment to co-operation	Low
Customer segment fit	
5. Complementing customer base	High
6. Complementing partnership network	Low
7. Partnership with competitors	Medium
Product and service fit	
8. Complementing products and/or services	High
9. Depth of product integration	Medium
10. Partner's competing product offering	High
11. Number of potential applications	Medium
Marketing and sales fit	
12. Strong global market footprint	Medium
13. Centralization or decentralization	Low
14. Need for solution packaging	Medium

Source: Varis, Kuivalainen and Saarenketo, 2005

The evaluation of Business Potential is more or less an intuitive guess about the financial implications of the partnership. The evaluation of the Product and Service Fit focuses on the feasibility of the partnership from the technical perspective. The evaluation of the Customer Segment Fit shows how the potential partner can assist the Network Operator in accessing the business ecosystem and its corporate markets. The Market and Sales Fit evaluation considers the partnership from sales and marketing perspectives.

4. Could the use of Open Source technologies and Open Standards by the Network Operator exploit the concept of Open Innovation?

Open innovation is a great way to acquire and share innovations with others. Yet, turning an innovation into a product requires a lot of additional functionality, as well as development and integration effort. Most of this functionality is being implemented in software and, as a result, the amount of software in products has risen dramatically in the past years. However, it

is becoming harder and harder for companies to develop all this software in-house, or even to buy this software from third-party software firms. Therefore, Open Source software can be seen as the right methodology to fill the gap between innovation and product (Engelfriet, 2007).

On the other side, information technology standards have historically been either fully proprietary or fully free. The use of Open Source software incentives the appearance of Open Source standards, enabling people and companies to compete in a structured way. Open Source standards pose an interesting challenge, because they fall into a gap between the two: they restrict the freedom of their users even while providing them with extremely low-cost and reliable technology.

Standards shall fulfil all of the following requirements (Rosen, 2005):

- The standards specification document must be publicly available, either free of charge or at a nominal fee;
- The standards must be owned and managed by an official standardization body or by an open group or consortium: it must not be owned or controlled by a single party, and no single party must have special rights on it;
- The standard must be defined and managed according to an open process: every interested party must be able to join the standardization process, which must be based on an open decision making procedure;
- The standards must be free to be implemented by all interested parties, without any royalty fee: possible patented technologies included in the standard must be licensed with royalty free non discriminatory terms;
- It must be possible to extend and reuse the standard in other open standards.

There are many technical, social and ethical reasons for the adoption and use of open standards. The main reasons are listed below:

- Innovation/competitiveness – open standards create a level playing field that ensures greater competition between large and small, local and foreign companies, resulting in innovative products and services (Chesbrough, 2006);
- Greater interoperability – open standards ensure the ubiquity of the Internet experience by allowing different devices to interoperate seamlessly;
- Customer autonomy – open standards also empower consumers and transform them into co-creator. It also prevents the vendor lock-in by ensuring that the consumer is able to shift easily from one product or service provider to another without significant efforts or costs;
- Reduced costs – open standards eliminate patent fees, resulting in a reduction of total cost of ownership (TCO);
- Privacy – open standards enable the citizen to examine communications between personal and state-controlled devices and networks.

The issue of the relationship between Open Source software and open standards is important and deserves careful consideration. It is necessary to guarantee that an open standard remains really open and is not jeopardized by anybody. This can be achieved in a variety of ways, such as:

- Open standards should be released by bodies that have the power to control the definition of a standard;
- Procurement practices of large customers (e.g., public administration) should have a strong discouraging influence on technology providers that do not adhere to standards.

Open source and open formats can be considered the best way to protect customers' rights. In particular, the main claims associated to the adoption of Open Source software and open standards can be summarized as follows:

- Users can inspect the source code and check that it does not accomplish unsafe or undesired operations;
- Users can take full control of software. They can change the company in charge of maintaining it. They can develop, fix, change, improve, and redistribute the code without restrictions and limitations;
- The adoption of open standards allows systems developed by different technology providers to interoperate. Therefore, a user or organization is not forced to use products from a single provider, and different users or organizations can communicate even if they use products from different providers. In particular, the adoption of open formats makes the users free to change a program without losing data and information. Moreover, anybody can access the information without necessarily purchasing or acquiring non-free programs.

The use of Open Source software and open standards by the Network Operator will drive the company to an important role in the open innovation paradigm. This will be particularly more important among SMEs, because small firms often lack resources to develop and commercialize new products in-house and, as result, they should be more inclined to collaborate with other entities, such as large firms, universities and R&D centres. Besides this, communication with external business entities, the development model of Open Source software involves the collaboration between firms, suppliers, customers and developers.

7.4.3 Scenario II: VoIP Service

7.4.3.1 Idea/Purpose

In this scenario a Network Operator wants to introduce a VoIP service. The Network Operator wants to provide a VoIP solution for its customers taking into account the required features (i.e., voicemail, call forwarding and call blocking) and a guarantee of a certain QoS level. This solution should offer vendor independence, but should also be highly reliable. Besides that, another important requirement is to develop a new VoIP solution with minimal development costs.

The available proprietary VoIP products do not seem to be the best choices, since these products are not vendor independent. Besides that, the assessments regarding security and product quality are not possible without access the source code and typically these VoIP solutions are very expensive. This was one of the most important reasons, allied with the licensing price, which lead FEUP, for example, to choose for the development of an internal solution.

Another possibility is to use an Open Source product. In the domain of Open Source there are some available solutions, and “Asterisk” is one of the most promising software in the field of IP-based telephony. Created by Digium, Asterisk is a complete PBX in software, which runs on Linux, BSD and MacOSX and provides all of the typical features expected from a PBX. Asterisk allows Voice over IP in many protocols and can interoperate with almost all standards-based telephony equipment using relatively inexpensive hardware. Other PBX solutions and SIP proxies/clients, which are very popular inside the OS communities and that can be used to implement this scenario are described in Annex Q.

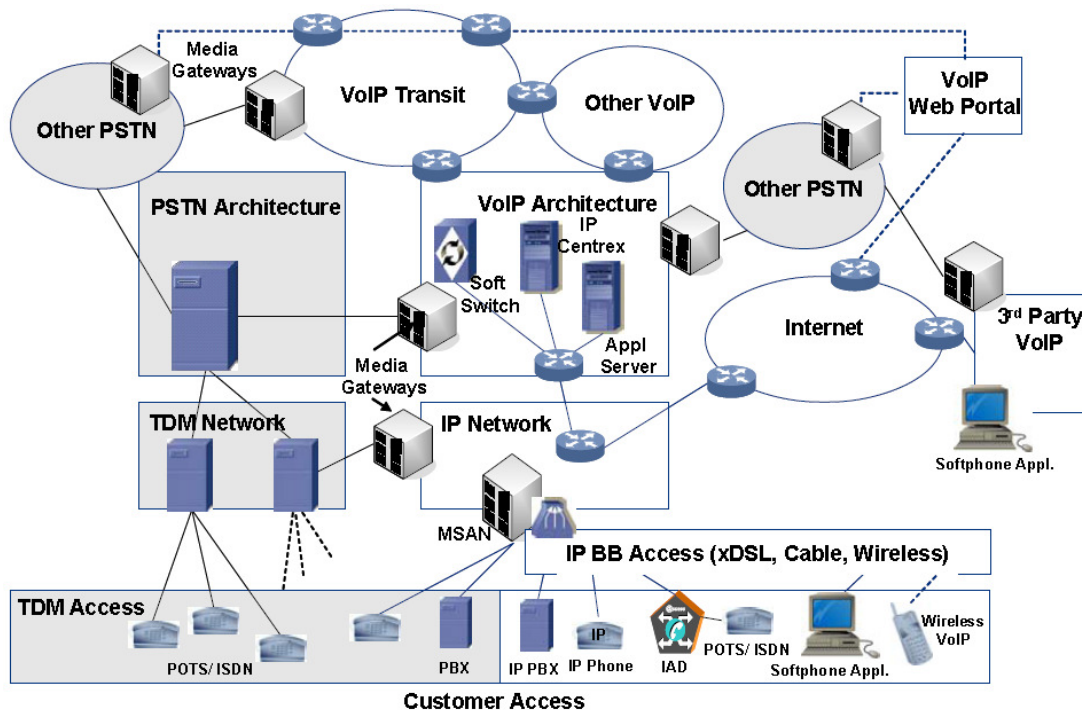
Asterisk is distributed under the GNU General Public License version and is also available under alternative licenses negotiated directly with Digium Inc. The GPL version simply requires that any code included with GPL code is redistributed under the same conditions as the GPL. This clause incentives the participation of the Open Source community in the project, which received several important contributions during the last years.

Basically, three VoIP cases shall be supported according to terminal equipments and types of network involved:

- Case 1: PC to PC;
- Case 2: Phone to Phone over IP;
- Case 3: Pc-to-Phone or Phone-to-PC.

The VoIP service shall have an access to the PSTN network in order to enable a VoIP end user to reach any other user in that network. This can be made using the “ENUM” protocol, which is a mechanism that transforms telephone numbers into Internet addresses and vice versa. In effect, by using ENUM, any VoIP user can reach any other customer via different communications channels just by using a traditional telephone number (STPP, 2003). This solution is followed by many VoIP companies. For example, in our case studies, we identified VoIP@FEUP and Netcall as using this approach to avoid billing VoIP calls made between their customers.

Customers should be able to choose between various access options, as it was presented by Detecon Consulting.

Figure 66: VoIP architecture implementations

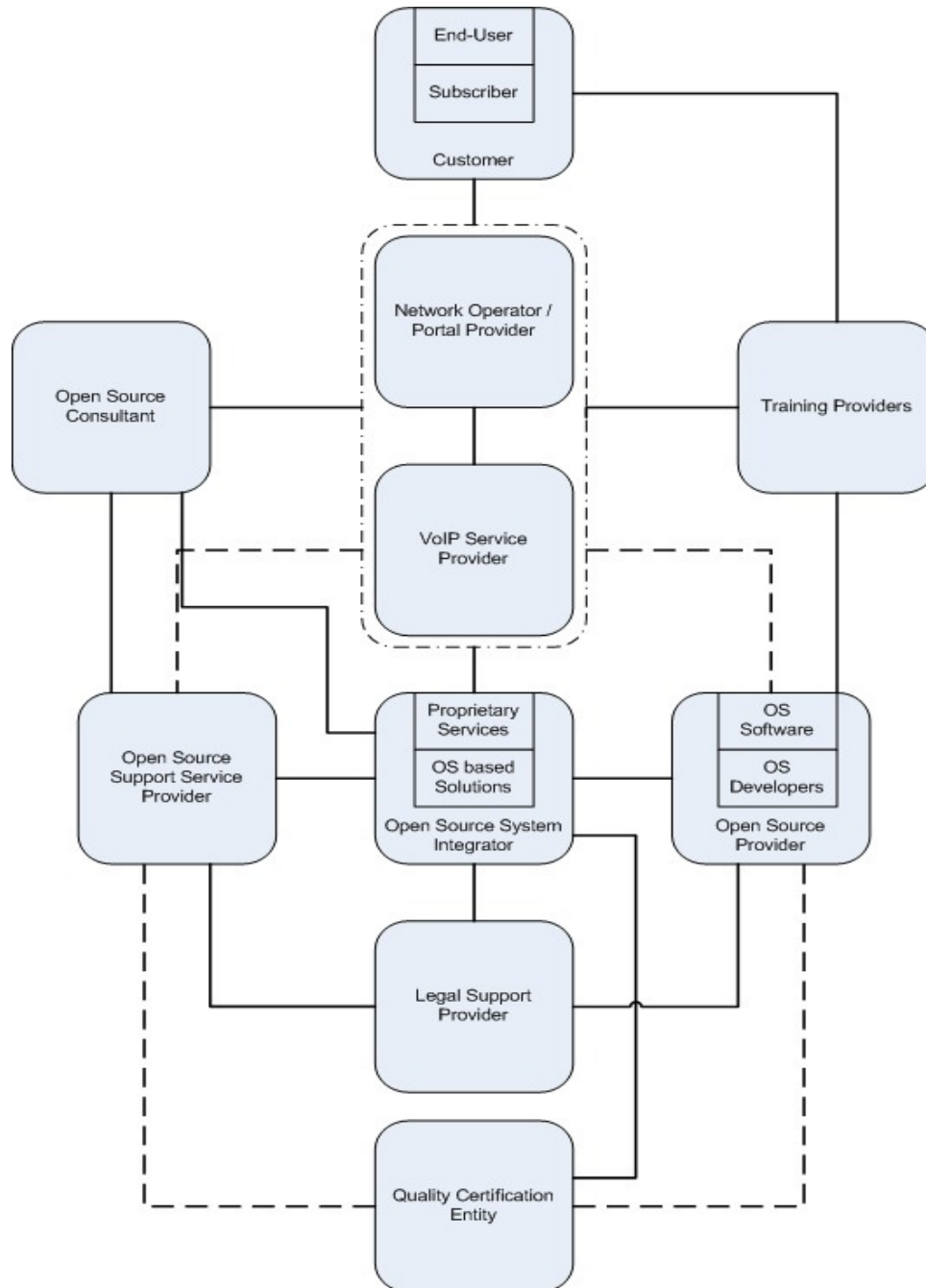
Source: Oehler, Max and Shanmugam, 2007

The list of the available access options according to the figure above is the following:

- TDM access options (no change for customers required) – Analog or ISDN phone connected to a TDM Switch or to a Multi Service Access Node (MSAN);
- VoIP access options (requires new equipment at customer premises) – Analog or ISDN phone connected to a terminal adapter or through a cable modem. It is also possible to use a VoIP phone directly connected to an IP line or use a wireless VoIP phone connected to an IP line or over private or public WLAN networks;
- VoIP access through IP-PBXs (requires replacement of traditional PBX) – Replaces traditional ISDN lines through broadband IP lines. Alternatively, it can be used as a hosted solution. In this situation, only IP based handsets will be installed at the customer sites and connected to an IP-PBX in the provider network (hosted IP-PBX);
- VoIP access through an IP Centrex solution – Only IP based handsets will be installed at customers' site. A carrier soft switch will provide communication, and IP Centrex server will provide PBX features.

In this second scenario, the end user has a relationship with an integrated service provider for broadband access, Internet access and IP telephony which runs a gateway to connect to the PSTN. Also, business customers use IP enabled private branch exchanges for telephony within the company on the LAN/WAN.

Based on figure 60 of chapter 7.3, we can instantiate and adapt it attending to the specific requirements of this scenario (see figure 67).

Figure 67: Diagram of scenario II

Here, we considered that Open Source Consultant role can also provide consultant services for the Network Operator and Portal Provider. These consultant services can be focused in the domain of VoIP technologies and also in the commercialization of VoIP services. Also, the VoIP Service Provider can extend its functions and act also as a Portal Provider. In this situation the VoIP operator is the same entity responsible for offering a direct Internet communication channel with the customer.

We must take in consideration that, because VoIP is a new technology, individual businesses will need someone who is well versed in the intricacies of VoIP. This role can be offered by

the training providers. They can basically offer two types of VoIP training courses: platform and non-platform specific. The platform VoIP training courses are basically certification courses offered by professional training teams that have expertise in OS VoIP platforms like Asterisk or sipX. Non-platform specific training courses may not result in a certificate for the trainee, but will have all the ingredients to educate the trainee on the details of VoIP technology and issues related to its implementation. These formation initiatives are particularly suitable for the communications and networking engineers' staff of the Network Operator.

The Quality Certification entity can deploy an important role for this scenario. The Network Operator must carefully look to some open issues of VoIP in terms of QoS requirements and security dilemmas. Expectations for the level of service and reliability of voice communications are generally different, and much higher, than the expectations for data communications. Therefore, it must be available in the market a QoS certification for VoIP solutions. On the other hand, we must protect the voice communications delivered over the network of a company. However, security mechanisms on an IP network almost always involve some overhead that affects performance. When the data is being transmitted this may not even be noticeable, but the delays added to initiate or setup a new communication round; as an example, the time required to encrypt and decrypt packets to secure the confidentiality of the VoIP conversations can adversely affect the quality of the call.

Other entities showed in this scenario will have the typical behaviour described in the section 7.3.

7.4.3.2 Building Blocks

Customer Segments

As long as human beings have their own personality, there will be different ways to communicate. For example, business communication differs from private communication and local calls differ from international calls. Customer segmentation can not be done easily and completely and some niche markets can be better provided by smaller specialized companies. However, we can admit that VoIP and its enhanced services are especially suited to particular customer segments:

- Businesses in full control of their IP LANs can obtain near toll-quality VoIP on those LANs. Technical problems are much less daunting due to the closed nature of the network, which results in greater reliability than on the Internet. This means that delay in processing and reception can be minimised and the quality of the calls are closer to the PSTN quality. VoIP via the Internet may also be adopted for inter-office communications, where quality is less of an issue than when dealing with customers or partners. Businesses can also set up web-enabled call centres, so that customers wishing to contact them by phone can initiate a call without having a second line or disconnecting their Internet session. Businesses, such as banks, can eliminate their toll-free number access charges by letting customers call a local number, from which they

are transported to an internal, centralised network. This essentially looks like a local call to the customer, and costs according for the business. Businesses that have high telephony usage, such as travel agents and financial services, will be the target of many new entrant VoIP providers;

- SOHO (Small Office/Home Office) premises have higher penetration rates than consumers for multiple telephone lines, PCs, and on-line services. Their high connectivity and multiple needs are an opportunity for VoIP service providers, who can provide a “virtual” second line and significantly enhanced services. Small businesses are also likely to be more willing to trade off convenience and quality for lower prices;
- International callers are willing to accept lower-quality international calls at a lower price, possibly the price of a local call or less than that, depending on which type of VoIP is used. Customers tend to be cost-conscious and more flexible than business customers regarding quality and convenience. Many large cities have high densities of people with strong foreign links. Offering VoIP between, say, New York and China, would allow service providers to build up large amounts of traffic between these locations. This backbone cost reduction seems to be one of the next generation telcos offerings. Gateways can be appropriately positioned, and a dedicated line could be set up between these destinations. This may allow for VoIP without use of the Internet and hence overcome significant QoS problems.

Value Proposition

Delivering a great value proposition from the Network Operator to the customer and user is essential, but a solid value proposition must also exist for the VoIP Service Provider. A different value proposition shall be formulated to different customer segments identified in the previous step. Each of these value propositions shall take in consideration the following elements:

- Flexibility & Scalability – The VoIP solution shall be designed to adapt seamlessly to the evolution of network infrastructure. The solution shall provide the scalability, reliability, and manageability to support hundreds of thousands of residential end users in a highly distributed architecture;
- Easy to deploy & manage – the installation of the VoIP solution shall be very simple. Adding a new customer, amending customer status, adding additional extension to a primary line or adding a secondary line can be done remotely using a web administration interface;
- Customization – the VoIP Service Provider shall offer to businesses and residential customers a complete set of tailored value-added services including administration interfaces, IVRs and standalone applications;
- Openness & Compatibility – the VoIP solution shall fully support MGCP and SIP protocols, allowing interoperability with any third-party MGCP and SIP compliant devices including IP/WiFi phones, IADs and PSTN/GSM gateways. The solution shall

easily be integrated with external OSS systems such as CRM and Billing. Bicom Systems, one of the case studies, has this competitive advantage, because they provide their own CRM and Billing solutions based in OS technologies;

- **Attractive Pricing Model** – the Service Provider shall lower their up-front investment and minimize their CAPEX. Also the customers shall have an attractive price for their calls with the guarantee of cheaper local, national and international calls;
- **Online Management Services** – shall facilitate payment methods and empower subscribers to make their own changes, e.g. setting up voicemail, call forwarding and adding a phone;
- **Innovative Calling Features** – the IP telephony shall enable businesses and residential customers to benefit from a broader set of standard and advanced features including call forwarding, caller ID, call waiting, call hold, call retrieve, speed dial, do not disturb and much more. Users shall also be able to check their messages from their phone handset, softphone or to be informed of new voice messages via e-mail;
- **Competitive VoIP Services & Bundle Services** – these services shall include IP video phones, enabling residential customers to add video to voice, enhancing distant family and friends relationships. Virtual numbers shall also be provided, allowing customers to have phone numbers that are independent of their geographical locations.

Communication and Distribution Channels

The choice of distribution channels is critical from the perspective of a rapid customer acquisition, taking in consideration that retail distribution can account for a significant percent of a VoIP service provider. Some distribution channels can be used to provide VoIP solutions, namely the followings:

- **Direct channel** – this is when the VoIP solution is directly provided to the customer;
- **Retailer channel** – this is when the producer sells to the retailer, and the retailer sells to the consumer;
- **Wholesaler channel** – intermediaries play a role here, as the VoIP provider sells to a wholesaler, and this last entity is responsible to deliver the product to the retailer and customer;
- **Agent or broker channel** – a complex arrangement involving several transactions, often because the merchandise is being imported. The VoIP provider sells to an agent that is responsible to choose a wholesaler entity for each addressable market. The wholesale entity will be responsible to deliver the solution to the retailer and customer;
- **Dual or multiple channels** – this refers to the use of two or more channels to sell products to different type of customers.

Regardless of the chosen channel, it always will be needed a well-constructed set of marketing supporting tools to help the sales effort, including high-impact communications, benefit/cost

demos, product functionality demos and easy-to-use post-sales materials. Providing educational information to the target market, despite the increased information flow from the large local exchange carriers, is an important part of the communication process.

Customer Relationships

Business customers typically cannot tolerate delays, errors, or failures when it comes to their voice services. Voice lines are a primary path to revenue and customer contacts. Businesses are extremely sensitive regarding anything that might jeopardize revenue, so building their confidence with a seamless transition to VoIP and a flawless administrative and end-user experience is necessary to win and also retain these high value customers.

Reliability and quality are always going to be concerns for a business that is looking to migrate to VoIP. Lower costs will attract them, but any perceived lack of quality can easily scare them away. Cutting expenses is not worth if it means that sales and customer interactions can suffer. Though typically reliability and quality issues around VoIP relate to quality of service and back up power, automated operational issues are just as important in building the customer's confidence once they are engaged. VipVoz gives a special attention to this requirement providing the only connection with VoIP brokers that offers a good quality of service, like it is PT and ONI in Portugal. Following this approach, the phone quality calls are always medium to high but, for the most part, the user will have a less competitive price.

Like the enterprise IP telephony market, the consumer or residential VoIP markets has definitely changed over the last few years and has its specific requirements that brought a raft of new challenges and opportunities for integrators, service providers and their partners. Despite the recent surge in the number of provider offering services for this market, the residential VoIP market still lags a long way behind the enterprise market in many key ways.

Residential VoIP primarily focuses on the benefits of reducing call costs, which is something that it does very well for a home user. On the other hand, enterprise VoIP focuses more on collaborative elements and treats call-cost reduction as secondary. Instead, it focuses on things such as unified messaging, staff mobility, desktop workstation conferencing, instant messaging and overall integration of computing and voice technologies.

Typically, the customer relationships channels that a VoIP service provider can use are:

- Live Instant Messaging – creates the possibility of real-time text-based communication between two or more participants over the Internet. Actually many IM services have additional features such as group chatting, conference services and file transfer;
- Website (self-service) – to have a web presence offers many benefits in terms of getting more leads and prospects, increase sales, enhance the professional “brand” and improve the customers’ service. Online customer service through the company’s web site can be operated 24 hours a day at minimal cost. It can provide customer support materials, frequently asked questions (FAQ) and feedback forms. Also, by email, companies can provide answers to their customers’ questions very quickly. Netcall and VipVoz gave a special attention to their websites, reformulating their images, improving

their usability and investing in a good position guaranteed in the most recognized search engines, as Google.

- Community – the community plays a large role in Open Source software, not only in terms of developing and fixing bugs, but also in terms of support for end-users. Frequently we can expect to get valuable information in forums that in an informal way of teaching how to configure and use an application. Also, the community will always be able to answer doubts and questions, sometimes faster than professional companies.

Key Resources & Key Activities

Here, we present a concise set of key resources available at each entity and the major activities that shall be performed by these entities.

1. VoIP Service Provider

- Technical competences in the fields of management and marketing;
- Brand image and reputation;
- Billing solutions (Prepaid and PayPal);
- Establish a direct relationship with customers;

The VoIP Service Provider is responsible for the commercialization of the solution or service. It's also the entity responsible to establish a direct relationship with customers.

2. Portal Provider

- Broadband Internet connection;
- Focus on the usability component;
- Worldwide accessibility;
- Establish a direct relationship with customers;

The Portal Provider is responsible to make the aggregation of content and to provide marketing campaigns for its customers.

3. Open Source System Integrator

- Personalization of solutions;
- Knowledge of Open Source and Commercial solutions;

The Open Source System Integrator is responsible to provide “best-of-breed” solutions for the Portal Operator and Network Operator.

4. Open Source Support Services Provider

- Specialized technical competences;
- Specialized resources in the security field;
- High specialized human resources;

The Open Source Support Service Provider is responsible to develop specific Open Source Solutions to complement the VoIP solution. These complementary solutions can include security, billing or specific hardware.

5. Open Source Provider

- Scientific and technical competences background;
- R&D projects and motivation to be involved in such kind of projects with a strong research component;

The Open Source Provider is responsible to develop Open Source projects in cooperation with other developers around the world.

6. Legal Support Provider

- Formation in legislation/laws and strong competences to understand the Open Source licenses;
- Knowledge of telecommunications regulation;

The Legal Support Provider is responsible for juridical advisory.

7. Quality Certification

- Competences in the domain of quality management;
- Independence and impartiality behaviour;

The Quality Certification is an independent entity which is responsible to evaluate the software provided by the Open Source System Integrator entity.

8. Training Provider

- Certification of competences of their employees;
- Regular internal formation of their employees;
- Knowledge of VoIP hardware equipments;

The Training Provider entity is responsible for the formation of human resources at the Open Source System Integrator role and at the Customer role.

9. Open Source Consultant

- Experience of their employees;
- Knowledge of Open Source and commercial VoIP solutions;
- Knowledge of accountability systems for telecom solutions;

The Open Source Consultant is responsible to provide consultancy services attending to the “best-of-breed” technical solutions available in the Open Source market and working methodologies.

Revenue Streams & Cost Structure

Here, we present the most relevant revenues and expenses for each entity following the proposed scenario.

The most important revenue stream of this scenario is the selling of VoIP solution to the customers. Usually, this solution is customized, taking in consideration the customer communication infrastructure needs of the customer. Also, the Portal Operator is responsible to get money from the component (national/international) of IP calls. Also, the Open Source Support Service Provider can get important revenues from add-on services like security and improved reliability of VoIP calls and can get some extra revenue selling IP hardware, typically IP phones, GSM gateways and telephony cards.

On the other hand, the most relevant expenses of this model are related with the technical infrastructure that the VoIP service Provider offers to its customers. Also, the Portal Operator will need to offer a robust Internet infrastructure and a billing solution.

In table 12 we show the major revenue streams and cost structure for the entities of this scenario.

Table 12: Major revenue streams & cost structure of scenario II

VoIP Service Provider	
Revenue Streams	Cost Structure
Selling VoIP solution	Human resources
	Technical infrastructure
	Paid services to other entities in the “model”
Portal Operator	
Revenue Streams	Cost Structure
VoIP services and communications	Internet infrastructure
	Paid services to other entities in the “model”
Open Source System Integrator	

Revenue Streams	Cost Structure
Selling the solution to the Portal Operator or Network Operator	Human resources
	Services paid to others entities
Open Source Support Service Provider	
Revenue Streams	Cost Structure
Selling support services	Human resources
	Services paid to others entities
Open Source Provider	
Revenue Streams	Cost Structure
Knowledge and status inside the OS project	Consumption of time and effort
New career opportunities	Some minor technical infrastructure (can also be considered redundant)
Legal Support Provider	
Revenue Streams	Cost Structure
Consultant services	Human resources
Quality Certification	
Revenue Streams	Cost Structure
Based in the certification's type	Human resources
	Certified fees (e.g., Asterisk formation)
Training Provider	
Revenue Streams	Cost Structure
Based in each formation provided to the customers	Human resources
Established contracts with Network Operators and Customers	Technical material
	Investments in continuous formation
Open Source Consultant	
Revenue Streams	Cost Structure
Consultant services	Human resources

Partner Network

The importance of a well-established partnership between the different entities of this scenario is very important. Essentially, it is very important to analyze the partnership between Legal Support Provider, Quality Certification Entity and Open Source Consultant with the Open Source System Integrator entity.

The Legal Support Provider is responsible to provide advisory services on Open Source licenses and telecom regulation. In our scenario, we propose to use the Asterisk solution, which is by far the most visible OSS VoIP technology. Asterisk is industry standard PBX software whose Open Source code is maintained and managed by Digium. When its source code was made available to the public, it proved to be so useful that it soon dominated the market. Although Asterisk is available for free in its unadulterated form, getting a version that is easily implementable by most users will cost some money. Users also need to pay for support, which is an important component of most of OSS business models.

During the last years appeared in market other VoIP applications like FreeSwitch and sipX. FreeSwitch allows users to make calls from their computer to regular telephones, something that had previously been impossible except with a proprietary softphone. sipX is an Open Source SIP PBX for Linux, which aims at commoditizing PBXs by offering a fully featured, standards-compliant, and easy-to-use SIP IP PBX for free as an Open Source solution.

The VoIP Service Provider shall take in a very special attention the implications of each license and its availability to be used with commercial software. For example, the GPL is the least proprietary, most consumer-oriented license, and it places strict limits on closing source code. Clarke, referred by Elwood, says: "When using GPL we have to be fairly careful how we use it in our products. People want to make money. That's one of the challenges of the open source" (Elwood, 2006). Elwood admits that this seems to be the line that companies walk on how to maximize the benefit of using the Open Source community, while still holding on the ability to close or restrict the source code when it is time to market a product.

The Legal Support Provider also has to encompass another important rule in the field of VoIP regulation. Some specialists consider that the IP technology is introducing new services and new characteristics to the traditional services that may need some regulatory actions and additional rules to improve the market efficiency and the consumer welfare (Vargens and Pinho, 2006). The approach of VoIP regulation is based on consumer protection, and implies some minimal obligations regarding quality of service, reliability of networks, security of information and conditions of interconnection and universal access.

The Quality Certification Entity will be responsible to certify VoIP solutions. This certification can be based on two very important variables when we talk about VoIP: security and QoS.

Currently, many key components of the global communications infrastructure have become breeding grounds for viruses, fraud and spam. Without ample protection, the VoIP networks can become infected with the same types of threats that already affect e-mail and instant messaging today. To perform well in VoIP environments, security appliances must both

protect the VoIP infrastructure and maintain the voice quality, availability and reliability of the connection.

Also, for VoIP to be a realist replacement for standard Public Switched Telephone Network (PSTN) telephony services, customers need to receive the same quality of voice transmission they receive with basic telephone services. Like other real-time applications, VoIP is extremely bandwidth and delay sensitive. In this way, a Quality Certification Entity can also deploy an important rule in the level of QoS certification.

The Open Source Consultant will be responsible to provide precise information about the solutions available in the VoIP Open Source market and the integration of these solutions with PSTN PBX centrals. This role can also be made by an university or research centre, like we described for the scenario I.

7.4.3.3 Model Assessment

In a first instance to assess the viability of the application of the proposed framework to this scenario we will conduct a SWOT analysis.

Strengths

- Development community and programming expertise – the Asterisk project receives contributions from several developers around the world. They typically have excellent technical skills in the area of telecommunications and networking;
- Lower costs of development process – the source code can be used as a start-point for the internal development and customization of VoIP solution;
- Easily customization – Asterisk solution can be easily customized to attend the specific requirements of an organization;
- Calls cost reduction – for companies, VoIP can make a big cost reduction in their national and international calls and costs can be cut through the dismantling of expensive leased trunk-lines calls.

Weaknesses

- Dependence on several entities – there are several players in the market and the complexity of coordination between them can be huge;
- Complexity of licensing – Asterisk is provided under GPL and commercial licenses. The GPL license is very restrictive and doesn't allow a company to redistribute an application without giving out source code;
- Cultural resistance – some more traditional network/telecom operators already made huge investments in traditional PSTN lines and can resist to the introduction of VoIP based services;

- Asterisk expertise required – even if Asterisk is easy to use and configure, it is necessary to spend some time learning the architecture of the platform to be able to configure some of its more advanced functionalities;
- Hardware issues – although VoIP standards have been developed, the level of interoperability between various VoIP networking manufacturers is yet immature. This situation happens especially with proprietary hardware, namely with CISCO devices.

Opportunities

- Attractiveness for the participation of Universities and R&D centres – universities and R&D centres with deep knowledge in the fields of networking and telecommunications can be participating in this model as Open Source Consultant entities;
- Suitable for start-up companies – this model facilitates the launching of new start-up companies with technical human resources that are currently working or studying at universities or research centres;
- Improved productivity – a study conducted by Deloitte in 2007 shows that businesses are increasingly turning to unified communications to give their employees greater flexibility and also to raise their productivity. Attending to this report, surveyed organizations reported that the drivers behind the adoption of VoIP and unified communications were to raise productivity, increase customer satisfaction and cut costs (Deloitte, 2007);
- Bundling of cellular and fixed – the fixed-mobile convergence enables today's separate fixed and mobile telecom services to be combined into a single subscription package that brings obvious advantages to end users subscribers, in terms of customizations and costs control.
- Integration of other value-added services – as VoIP sends all data through the network in packages, it is not difficult to incorporate other data than digitalized voice.

Threats

- Internet connectivity issues – the quality of VoIP calls is very dependent of the broadband connection type of the customer. VoIP issues usually result from high latency, packet loss, jitter, or temporary loss of the Internet connection and can result in everything from delayed voice to dropped calls;
- Security of VoIP – the current Internet architecture doesn't provide the same physical wire security as the phone lines. Therefore, the key to securing VoIP is to use the security mechanisms like those deployed in data networks (firewalls, encryption, etc.) to emulate the security level currently enjoyed by PSTN network users;
- Big operators and hostile strategies – there is the issue of potential revenue reduction for countries where private operators or state-owned companies have a stable dominant position in the market;
- VoIP regulation – new regulations could have some implications not foreseen yet and thus, present a degree of uncertainty for the moment.

Attending to the Osterwalder model, we will consider some pertinent questions to evaluate our proposed framework.

The first question analyzes if the Network Operator knows exactly the needs of their customers. To analyze this situation, we will take a look for each VoIP considered segment for this scenario, respectively: business companies, SOHO and international callers. We will look to the motivations and needs of each customer segment and formulate a targeted business proposition for them.

In the second question we will look to the actual landscape of competitors. We will compare several VoIP solutions available in the market and we will compare our Open Source VoIP approach against VoIP solutions based in softphones and against proprietary closed-source solutions.

The third question will look with more attention to the distribution channels considered in this scenario to understand how these channels are in terms of customers' acquisition. In addition, we will analyze the characteristics of products that make them more or less appropriate for each distribution channel.

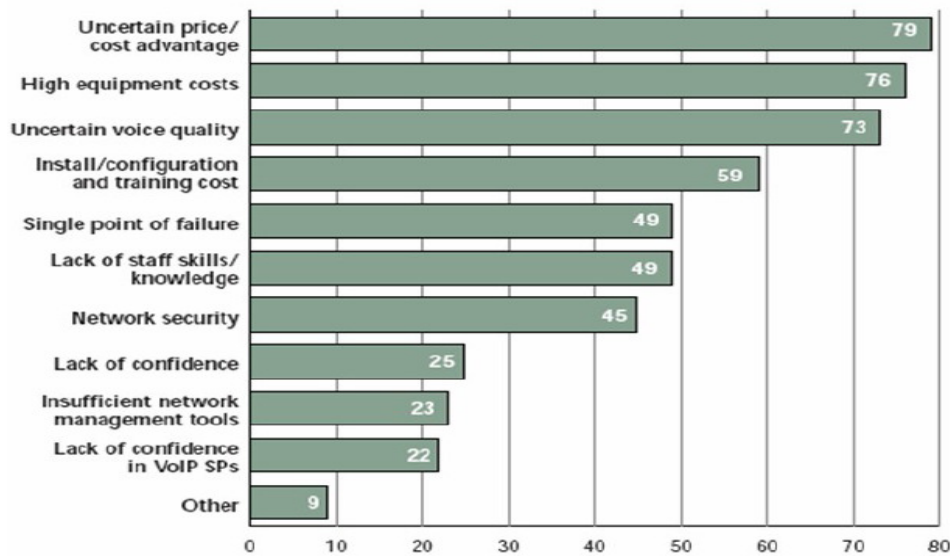
1. Does the Network Operator know its customers' needs good enough?

As we considered in section 7.5.2, there are three possible segments of VoIP customers, respectively:

- Businesses companies;
- SOHO (Small Office/Home Office);
- International callers.

Big companies are using Business VoIP to move their call centers to where it's cheaper to operate. With this decision, some big companies are able to save thousands of dollars per month in voice communication fees. At the same time, the IT department will gain control of the company's phone system. They can manage every phone configuration from a web GUI and setup the phone system to work on the company's data network. On the other hand, travelling sales representative will get important benefits, considering that when the staff is travelling abroad, phone calls can be very expensive. Most of the time when we are travelling to hotels around the world or in airport terminals, we have access to Hi-Speed Internet for free. Using the Internet connection we can setup our personal hi-tech communication center.

In a study conducted by Yankee Group in 2004, the top concerns of CIOs are voice quality, availability and security. These results are available in figure 68.

Figure 68: VoIP top concerns of CIOs

Source: Matthys, 2005

Attending to figure 68, we can confirm that security has to be treated as an important factor for companies to decide whether or not to make the transition to VoIP. Also, as stated in figure 10, uncertain voice qualities, single point of failure and lack of know-how are real inhibitors for CIOs to make the jump to VoIP.

The SME companies might think very well in the VoIP features that they need to implement. Usually, they just need basic features, such as call forwarding, voice mail, three-way calling, etc. However, small businesses can benefit from some of the more advanced available features sets in unique ways. In fact, the right set of features can make a small business look much bigger at the eyes of their customers (and potential customers), partners, vendors, and others with whom they do business over the phone. Usually, SME companies are looking to implement the following top five features:

- Auto attendant – seen as an extension of voice mail, auto attendant is a basic feature of high-end IP phone systems and IP PBX units. For example, the auto attendant feature in the Asterisk Open Source IP PBX lets the company to play music or pre-recorded messages to customers on hold, and it uses a voice mail “tree” that supports directories by department, employee or extension. In addition, auto attendant software can answer incoming calls to a central number and route those calls based on the caller’s need. For example, the caller can choose to route the call to the sales department, billing department, accounts receivable, etc. In a small organization, one person or department may perform all of these functions, and the call may end up at the same extension for multiple choices;
- Find Me, Follow Me – another popular feature is Find Me, Follow Me (FMFM). This feature allows employees to move around. Either within the organization or outside it, and still receive calls as if they’re sitting at their desks. It is possible to configure the system, so that when a call comes in for an employee, the desk phone rings first, then the employee’s mobile phone, then his or her home phone, until the system finds the

- employee. Also, the employee can use the Follow Me functionality to define the phone number of the location where he or she will be and have all calls routed there;
- Presence – this is an extension of the FMFM functionality. Rather than passively depending on users to set up locations where they expect to be, the presence feature can actually track them down. For example, the system can detect that a user logged onto his or her email account from a computer in the accounting department or checked voice mail messages from a phone at the reception area, and it can then extrapolate where the user is;
 - Conferencing – a VoIP system can support audio (and perhaps video) conferencing. High-fidelity wideband VoIP conference phones allow multiple persons at a conference table to participate in a VoIP conversation from different distances, speaking at a normal volume. The company can also tie conferencing functionality into other IP collaboration applications, so that during the conference call, participants can exchange files, synchronize calendars, share presentations, and even see one another's computer desktops;
 - Convergence – the basis of unified communications is the convergence of different technologies in order to work together. The same communications system can handle phone calls, voice mail, email, instant messages, video conference, faxes, and others types of communications, and different applications are aware of one another.

In the past few years, VoIP solutions have gained a good acceptance in the SME market, because they are less expensive, have more capabilities, and can be more easily integrated with IP network than traditional voice applications. The Open Source VoIP movement has the potential to lower the cost of voice applications and spur additional deployments. According to Korzeniowski, small and midsize businesses should take a close look at this option because it may be a good fit for them (Korzeniowski, 2008).

The typical international callers are willing to accept lower-quality calls at a lower price, and nowadays the costs of making VoIP calls is at least three times cheaper than the traditional international calls. Interestingly, it is the bandwidth that governs the quality of the voice heard over the Internet in an international call. With a high bandwidth connection one can get better sound quality. However, in any situation, the voice data is passed even when there is apparent network congestion and the VoIP service is up loaded like any other software application. Also, professional international callers, usually associated with big companies, can also interconnect many offices at a different geographical location and benefit from free long distance. For a business with offices scattered around the world, they can be interconnected with a smart PBX that will transparently manage the calls.

2. How well customers are being actually served by other competitors?

Companies selecting a VoIP solution must choose from a dizzying array of options, including a hosted, hybrid-hosted or premise-based telephony system that will better fit their needs. There are several VoIP solutions available in the market, and we are especially interesting to

compare the proposed Open Source VoIP approach for this scenario against the following two kinds of solutions:

- VoIP solutions based in softphones and free/low cost calls;
- Proprietary closed-sourced solutions.

The most popular VoIP solutions based on softphones are Skype, Google Talk and VoIP Buster. We will analyze in more detail the Skype solution and will enumerate the major capabilities and disadvantages of this solution.

Skype is a software-based solution that allows users to make telephone calls over the Internet. Calls to other users of the service and to toll-free numbers are free, while calls to other places and cell phones can be made with a small amount of money, compared to typical traditional telecommunications systems. Skype supports additional features including instant messaging, file transfer and video conferencing.

The Skype VoIP application is interesting, since it uses Peer-to-Peer technology to let end-users place calls more or less free of charge and for private and residential use, Skype application can be considered a quite decent choice. For the corporate world, however, Skype application is probably unsuitable for several reasons, attending to the study conducted by Bergstrom from University of Stockholm. His opinion is based in the following five reasons (Bergstrom, 2004):

- As call-handling is seemingly done by super-nodes it is hard to confine the Skype application to a corporate network. At some point the Skype application clients inside the corporation must connect to external entities, not only the centrally managed back-end servers, but also to an arbitrary super-node which, in most cases, is some other Skype application end-user;
- A corporation would probably have little or no influence on the traffic pattern of the Skype application clients, nor any chance of decent error-handling, since most of the logic behind the Skype network is handled either by Skype managed back-end servers or external super-nodes;
- All file transfers in Skype application are encrypted the same way as the Instant Messaging and speech, which raises some concerns when a Skype application user resides within a corporate LAN/WAN and receives one or more encrypted files that cannot be scanned by corporate anti-virus or screened by a firewall;
- The Skype application in itself raises some concerns, not only the quite peculiar End User License Agreement (EULA) considered by Bergstrom, but also the pro-active measures that the application enforces to withstand reverse-engineering;
- The absence of good documentation on how the link-encryption and key-exchange is done can be considered quite worrying. Private conversations by end-users are probably often not confidential, but corporate use of the Skype needs more guarantees about the privacy of their calls.

The proprietary closed-source solutions are usually associated with big-vendor companies like Cisco, Alcatel, Avaya or Nortel. They provide integrated VoIP solutions with their equipment and usually can be considered a good option for a company that already has a PSTN line

from these big proprietary companies. However, what the customers wants is to have a VoIP solution with a better price, better performance and ease of use. Looking to these requirements, we can easily realize that Open Source VoIP solutions can be seen as a valid alternative with a better price and better flexibility. However we must pay attention to the integration issues with PSTN PBXs. This was one of the most difficult challenges for VoIP@FEUP, when they tried to integrate its VoIP PBX with Alcatel PSTN PBX. The VipVoz, other company analyzed in the case studies section, didn't succeed when they tried to integrate their VoIP solution with a proprietary PSTN PBX, because that solution didn't follow the RFC protocols standards.

Besides that, VoIP Open Source Solutions are being well accepted by the market and have a high-grow potentially. Recently, Nortel announced that will launch in a near future one IP PBX solution based in Open Source software for the SMB market. They choose the sipXecs from Pingtel, one PBX that works only with SIP protocol (York, 2008).

3. Does the Network Operator know how successful its channels are in terms of customer acquisition?

In the section "Communication and Distribution Channels" in section 7.5.2, we defined five distribution channels that can be used to provide the VoIP solution to the market, namely: direct channel, retailer channel, wholesaler channel, agent or broker channel and dual or multiple channels.

There are several characteristics of product lines that make them more or less appropriate for a particular type of channel. Briefly, these characteristics can be summarized as follows:

- The products themselves – if a product is perishable, it requires the shortest and most direct distribution channel, which means the fewest possible intermediaries along the way. If a product is customized, like an expensive assembled-to-order computer system, it also benefits from a short distribution channel;
- The type of customer – a channel may be chosen because it best reflects the end users' buying habits. Business-to-business customers have completely different needs and buying habits than individual consumers;
- Market size – it is easier to sell directly to consumers in a large city with lots of potential outlets for a product line. The more widely dispersed the stores, the more logical the dependence on agents and wholesalers, or multiple retailers in different cities, to keep product sales strong and steady;
- The producer's level of control – some manufacturers wants to have an exclusive distribution channel. They've worked hard to build an exclusive reputation, and they expect their distribution channel to work just as hard to protect and enhance their upscale image;
- The size of the producing company – a producer is likely to sell directly when the company is large enough to handle the additional responsibilities that intermediaries would otherwise provide, like credit to customers, warehouses for their own goods, the ability to hire and train their own sales representatives;

- The size of retailers – a segment of the industry that is fragmented, with most of the stores operating as single units, requires the distribution channel to be longer.

Attending to the characteristics of VoIP solutions, we can establish an evaluation between the type of channel and the most important general characteristics that help the producer of the product to choose the most adequate type of channel to his product line. This evaluation is done in the table 13. The existence of more stars means that is better or bigger, except in the “type of customers” criterion, which the existence of more stars means that the customers need the establishment of a more personal relationship.

Table 13: Evaluation of the best distribution channel for VoIP solutions

	Product Specifies	Type of Customers	Market Size	Producer's Level of Control	Size of VoIP Companies	Size of Retailers
Direct channel	****	****	*	*****	**	*
Retailer channel	***	***	***	***	***	***
Wholesaler channel	**	**	****	**	****	****
Agent or broker channel	**	**	*****	*	****	****

From table 13, we can say that the direct channel is appropriate for VoIP solutions that contains a lot of technical specificities and can't be customized easily. Besides that, a direct channel is adequate when the VoIP provider wants to keep a close relationship with the customer. It's especially recommend when the market size is small and we don't have in the market big retailers to let the company take advantage of economy of scale.

On the other hand, a wholesaler channel and broker channel can be used when the VoIP provider offers an easily customized solution. When this happens, the VoIP provider can offer a single one application that can be adapted by the retailer or end user (in some situation, where the customization can be done using a friendly interface) to the requirements of the customer. The use of a wholesaler or broker channel lets the company address a large market size. The use of this distribution channel is especially suitable when the size of retailer is big and they have strong relationships with local retailers of different geographic markets.

Finally, a retailer channel is suitable when we want to keep a strong relationship with a local partner, and when the use of this local partner is a competitive advantage for the VoIP provider. When we deal with a small amount of retailer channels we can increase the degree of collaboration between these entities and we can get important feedback from the market.

7.4.3.4 Model Innovation and Improvement

Attending to the Osterwalder model, we will consider some key questions to address possible innovation paths of our proposed framework.

The first question tries to regroup the customer segments according to the end-user customers' needs. This approach will let the Network Operator to build a customized solution that contains the most important technical and no-technical features that must be available according to the new customer segmentation.

The second question looks to the customers of VoIP solutions and tries to find out if they have other complementary needs that can be directly offered by the Network Operator or by one or more of its partners.

The third question tries to find a solution for the issue related to the attention that requires unprofitable clients. In a VoIP scenario, this is a very relevant issue, because the Network Operator can have a long list of clients, which most of them don't generate revenue. Therefore, it is important to consider a strategy that takes in special attention the profitable customers, but don't abandon non-profitable customers that could affect the image of the company in the market.

1. Is it possible to better regroup/segment customers according to their needs?

In section 7.5.2 we identified three possible segments of VoIP customers: business companies, SOHOs and international callers. This segmentation was made taking in consideration the business activities and their dimension. However, this segmentation doesn't reflect entirely the customers' needs, because we can have very different users' profile inside these three big identified segments. Another approach is to consider VoIP market segments attending to the end-user customers' needs. Following this last approach, we identified the following classes of users:

- Early adopters – this market is the first to adopt new technologies. Their purchasing decisions are based more on “wants” than “needs”. The growth trend of this market is small;
- Unhappy conservative – traditional PSTN users are moving to VoIP solutions to get a lower price, more portability and vendor independence. The growth trend of this market is large;
- Me-too followed – this market is similar to early adopters, but they are not necessarily the first to the market. They mostly want things because other people have them. The growth trend of this segment is low because it represents a small fraction of society;
- Teenager students – this segment is mobile and comfortable with computers and advanced technology. Its size is quite large and is replenished every year, in the beginning of school classes. It is an extremely important segment due to its size, its young age, and its ability to influence other segments;

- Impulsive buyers – this segment is relatively small, but still important because it contributes to market growth and does not require extensive additional marketing. This segment is not expected to grow much over time;
- Web enthusiasts – this segment loves the web and all things that have to do with it. This segment is of small to medium size, but it is very important because it continues to grow;
- Value customers – this segment wants low cost, but is willing to pay extra for additional functionality. This segment is extremely important because it is large and growing, especially when the economy is not;
- Bottom feeders – this segment's over-riding concern is price. This market is small in comparison to value customers, and not expected to grow appreciably;
- Connected/Integrated market – this segment is pre-concerned with being connected, often to their customer base. Cost is not a major issue. With globalization and virtual workplaces, this market is of medium size and expected to grow;
- Mobile market – this segment is mobile, as the name implies, and values the ability to remain connected while away. The portability of the VoIP adapter box is what differentiates this group from just the connected/integrated group above. With globalization and virtual workplaces, this market is of medium size and not expected to grow appreciably;
- Travelling business market – this segment is large, highly mobile, comfortable with new technologies, would like to keep a common phone number, and they are very familiar with the hassles of changing phone services, especially when stationed overseas. The VoIP growth prospects here are large, because market penetration in this segment is low;
- Hotspot market – this is an indirect market segment, which intention is to establish the necessary consumer awareness to help build the market for VoIP phone service. One example could be the setting up of free call centers to divulge new and promotional services to introduce people to the technology. This segment will grow as consumer awareness of VoIP increases;
- Elder care market – this segment is where adults are taking care of their aged parents. Auto payment features, phone number transferability, and ability to easily check their messages are very important to them. This segment is expected to grow based solely on demographics.

In table 14, we present the most important technical and non-technical features that must be available for each market segment considered previously.

Table 14: Most important features for each VoIP market segment based in consumer needs

	Early adopters	Unhappy conservative	Me-too followed	Teenager students	Impulsive buyers	Web enthusiasts	Value customers	Bottom feeders	Connected/Integrated	Mobile market	Travelling business market	Hotspot market	Elder care market
Technical Features													
3-way calling	X		X	X			X		X	X		X	
Voice mail – phone			X				X		X	X	X		X
Voice mail – web	X			X		X	X			X	X		
Caller ID		X		X			X		X	X			X
Call forwarding	X		X	X			X		X	X	X		X
Number portability				X		X			X	X	X		
Simultaneous ringing	X								X	X			X
e-mail message notification	X		X	X		X	X		X	X	X		X
Virtual exchanges	X						X			X			
Non-Technical Features													
Low price				X	X	X		X				X	
Predictable expenditure		X	X	X	X	X		X	X			X	
Simplified billing	X	X	X	X			X	X	X				X
Unlimited calling plans	X	X		X		X		X		X			
Limited calling plans		X					X	X					X
International calling plans		X							X		X		
Real time account management	X						X		X	X	X		
No contract		X		X	X	X	X						
Free trial period	X			X	X	X		X	X			X	
24/7 customer support							X		X			X	X

Attending to the table above, we can realize that the 3-way calling feature is very important for the early adopters and teenager students segments, because they are always looking for new innovation features. This 3-way calling feature is a rudimentary phone conferencing functionality, which allows communication to two other persons at the same time, making a three-person conversation. The voice mail feature will allow users to retrieve messages left for

them by incoming callers. The “voice mail – phone retrievable” functionality is not unlike the voicemail offered by cell phone and analog telephone companies. However, the “voice mail – web retrievable” will allow the users to access this information through a Web page. Thus, audio messages can be played from the user’s computer online or voice messages can be transcribed into text and delivered to the user’s email address. Looking to the non-technical features, we can realize that low prices and unlimited calling plans are very important for the teenagers students segment. On the other side, early adopters prefer a simplified billing system based in credit cards acceptance and a real time account management system.

2. Do VoIP customers have other needs that could be easily satisfied by the Network Operator (isolated or with partners)?

Typical business customers have other needs than just a communication system based in VoIP and in an IP-PBX system. They also need to have an integrated solution for their critical IT related activities in the office, concretely in terms of data managed services and hosting solutions. The data is the lifeline of a business and it is very important that it is protected. Therefore, an important market exists to provide network and security solutions, namely firewall, VPN connections, storage and backup/disaster recovery. This situation was introduced and described in the scenario I of this thesis. Besides that, a company can also offer hosting solutions and Web developing.

Business and residential customers would like to have integrated their communication devices and applications that can implement the following functionalities:

- Real time video sharing – a multimedia peer-to-peer streaming service that can be implemented combining the capabilities of the circuit switched and IMS packet switched domains. In this combinational scenario, the service enriches the user experience during a circuit switched telephony call by, for example, exchanging pictures, video clips or live video over a simultaneous IMS packet-switched connection;
- Interactive gaming – a multiplayer and mobile gaming platform that can be used to take advantage of the video and voice capabilities;
- Shared folders – content sharing enables users to share files between terminals. A typical use case includes sharing of files or contents such as images, documents, notes, contacts or calendar information, even simultaneously while in a voice-call session;
- Instant messaging services – it is a communication service that allows end-users to send and receive messages instantly. The expectation is to bring the same service experience to the mobile world, including interoperability without the need for legacy infrastructure;
- Voice messaging – it is a form of instant messaging where the content of the message is an audio file. Using an application in the terminal, users can record the message instantly or use existing audio files stored in the terminal’s folder;
- Video conferencing – the video conferencing service extends the point-to-point video call to a multi-point service;

- Video on demand or audio on demand – this feature would allow users to select and watch/listen video or audio content on demand. This functionality could be extended to support home shopping, games, and movies on demand;
- Location-based services – this feature can be seen as an information or entertainment service, which is accessible with mobile devices through the mobile network and with the ability to make use of the geographical position of the mobile device. This turns possible to provide to users of mobile devices personalized services tailored to their current location.

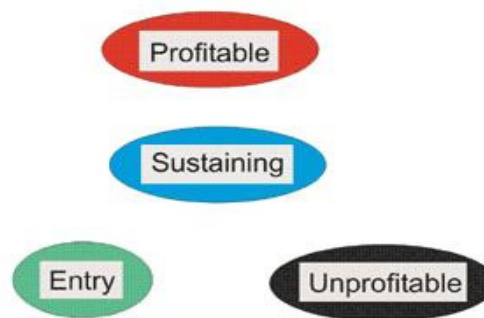
The IMS architecture can be used to deliver such kind of services. This situation is introduced and described in the scenario III of this thesis

3. Is it possible to spend less time and resources on unprofitable clients?

Understanding customer profitability is especially valuable for service companies, such as telecommunications operators. This importance increases when we talk about VoIP communications, because the typical prices of communications are relatively low and it isn't easy to create a loyalty program to attend the specific requirements of this customer market. In fact, for a VoIP telecom operator, customer profitability is far more important than product profitability, because the costs of providing a service product are usually determined by customer behaviour.

In figure 69, we show the basic customer segments into which an organization can place its customer base.

Figure 69: Customer segmentation based in customer profitability



Source: Inmon, 2005

In figure 69, we considered that profitable customers are customers that originate direct profit to the company. Sustaining customers are clients that can be considerable profitable in a long-term perspective. Unprofitable customers are fundamentally different from entry customers. Entry customers are those who have been enticed to be a customer. Oftentimes, the company may have created a loss leader or, the company may have made a conscious decision to attract market share. Many customers are initially attracted by a purchase that loses money for the company, because the company hopes that it can convert many of the

entry customers to be regular or sustaining customers. By retaining them as regular customer, the company hopes to sell products and services at a higher margin of profitability.

There are several reasons why a profitable customer may become unprofitable. Some of those reasons are:

- The customer is “high maintenance”. The demands the customer makes are unusual or unreasonable. These special requirements and service demands greatly reduce or eliminate the margin of profitability;
- The customer requires more advertising and marketing to get new orders. The cost of providing the advertising and marketing is more than the profit margin made on the orders placed by the customer;
- The customer only orders low-margin services;
- The customer uses those services so infrequently that there is very little profit margin in any case.

Therefore, it isn't to realize the difference between an entry customer and an unprofitable customer. With an entry customer there is hope that the customer will start to become profitable. With an unprofitable customer there is little or no hope that the customer will become profitable.

Differences in customers' lifetime value provide a new and interesting way to segment them. With the increasing availability of customer-based information as well as sophisticated CRM software and analytical tools, telecommunications companies can rank their customers by long-term profitability. In this way, segmentation and one-to-one marketing are no longer based on demographics or customer preferences alone, but are complemented with an assessment of customer profitability.

We must keep the idea that all customers are important, but some are more important than others. Given that customer service is expensive, it makes logical sense to provide a high level of service only to high-value customers. This idea of “service discrimination” in the telecommunications industry is similar to the concept of price discrimination that we see in other industries, such as the airline business.

7.4.4 Scenario III: IMS based Services

7.4.4.1 Idea/Purpose

In this scenario, a Network Operator wants to be able to provide a converged fixed-mobile solution to its customers composed by a different wide range of applications, like instant messaging, IP Centrex, Video on Demand (VoD), presence, personal information management (PIM), gaming and location based services.

The Network Operator shall be able to utilize a common infrastructure to support a variety of messaging technologies, including IM, SMS, MMS and e-mail. This shall result in a simpler service environment that is easier to build and less expensive to maintain and enhance. The

notion of presence will turn possible to have a coherent image of an end user's presence state, irrespective of the service applications or client requesting the information. Also, the infrastructure will take in consideration the information recorded in PIM devices, such as calendars and active phonebooks. The user shall also be able to receive alerts and personal announcements.

The user shall benefit from the availability of location-enabled services. The possibility of locating places of interest, friends or family, or determining their own location on demand, has obvious benefits for users and can be applied in a huge number of applications. Besides that, the Network Operator wants to be able to provide a gaming solution. Nowadays, mobile entertainment holds the potential to generate considerable revenue for third-generation networks and can be seen as a strategic asset. We want to introduce a gaming solution that can be multiparty, mobile and combined with chat and voice. At the same time, coupled with the real-time communication capabilities, the games can provide a catalyst for the formation of online communities which, it turn, produce a social framework for individual and group communication.

The considered architecture shall provide a virtual PBX that supplies the sophisticated capabilities usually found in premise-based PBXs, such as extension dialling, automatic call back, conference calling, calling forward and transfer. Virtual PBX shall also introduce the concept of "virtual receptionist" and brings the ability for all lines to be dialled directly, without requiring the intervention of a receptionist.

Finally, all of the services presented before will be able to be combined, originating new integrated services like voice plus video sharing, chat plus gaming and message plus calendar.

The IP Multimedia Subsystem (IMS) architecture is the best suited for blending of real-time and non real-time multimedia services and it optimizes the application life-cycle through rapid and efficient service creation and deployment. Further, basic IMS services such as Presence and Messaging, among others, can become enablers of larger, personalized, interactive and collaborative multimedia services. The capability to reduce the lead time for new communication services will guide to faster return on investment. The capability to personalize new services will increase customer satisfaction and brand value. Taken together, they will facilitate mass-market customization and will increase the revenue and brand value.

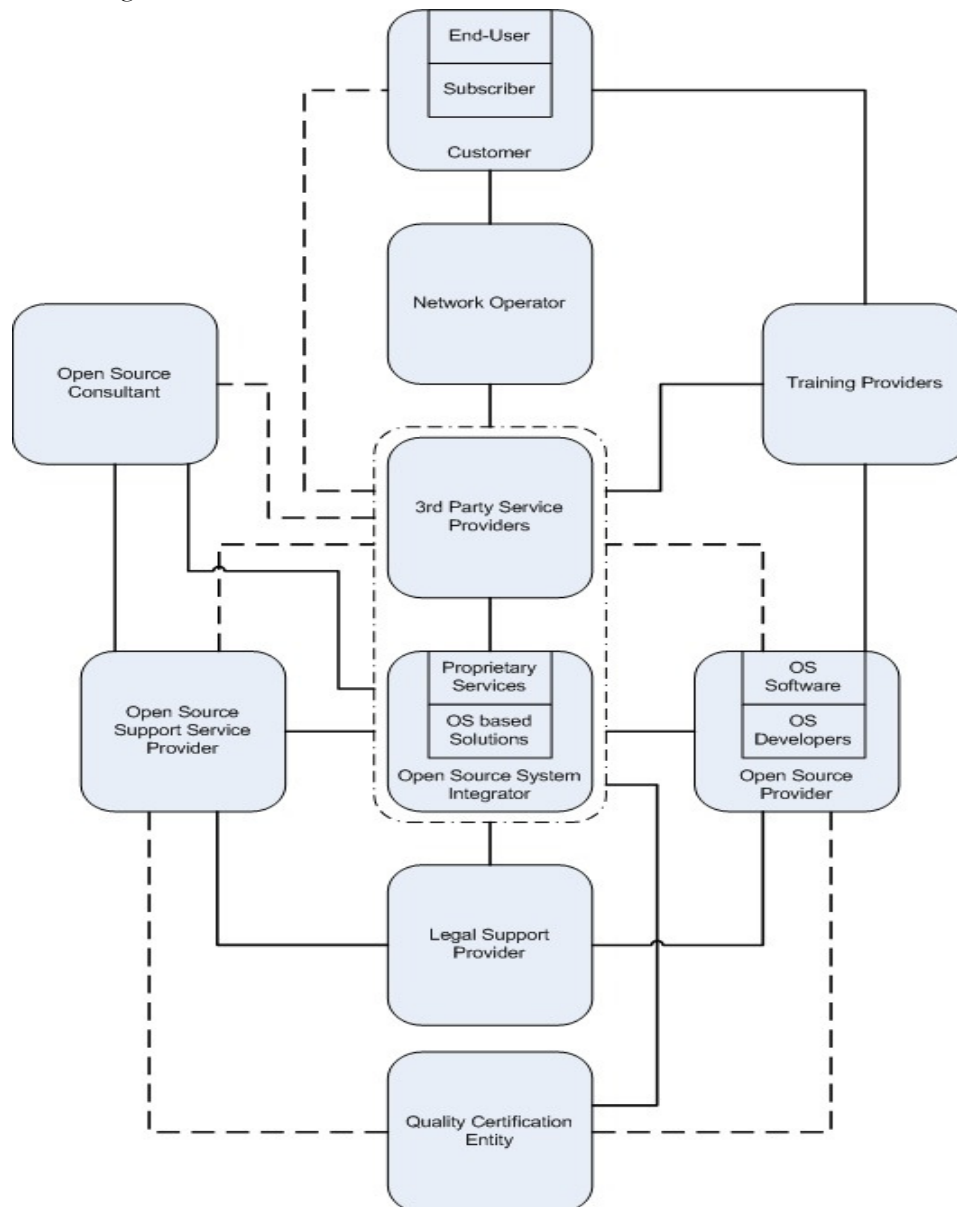
This transition to an all-IP IMS network for voice, video, and data will have significant implications for the telecommunications industry. While it provides operators with renewed growth in the converged world, it also identifies market competition with traditional fixed network operators and other new entrants. New players in the value chain, such as application and content providers, will likely precipitate new business relationships and relationship models.

IMS supports the concept of an Open Source creation model that allows the inclusion of third-party applications and application servers, enabling operators to tailor services and applications for their customers. Operators can develop the new services themselves, outsource the development work, or purchase IMS-compliant applications from external

sources (Pino, 2006). This potentiality of IMS architecture, allied with the flexibility of our framework, makes the creation and deliver of Open Source based services easier.

Attending to the figure 60 of section 7.3, the generic open source business roles model can be instantiated and adapted taking into account the specific requirements of this scenario (see figure 70).

Figure 70: Diagram of scenario III



In the figure 70, we considered that IMS is designed as part of the network operator architecture and can be controlled and owned by it. This scenario also includes the creation of an operator driven “trust” centre: the operator will become the account holder for the customers by offering various mercenarily services and service bundles (single-sign-on). In this scenario we considered that the 3rd Party Service Provider can exist separately or can be joint with the Open Source System Integrator to provide value-added services based in OS

solutions. Thus, the 3rd Service Provider can act as a small integrator of OS solutions in specific domains of the overall IMS architecture, such as mobile entertainment and location based services.

The customer will pay for the data transport and for 3rd party services and the Network Operator will retain a percentage to pay for the service to the 3rd Party Service Provider. The Open Source Consultant will be responsible for technical consultancy in the fields of location based services or gaming to the Open Source Support Service Provides and to the Open Source System Integrator. In some situations, the Open Source Consultant can offer business consultancy for 3rd Party Service Provider and facilitate its relationship with the Network Operator.

7.4.4.2 Building Blocks

Customer Segments

The actual scenario can address a wide range of customer segments depending on the different kind of services that are provided by the Network Operator and Service Providers. The IMS architecture brings some important benefits for the Network Operator in terms of customer market, especially the followings:

- Creation of customer loyalty by providing lifestyle communications environment;
- Opening of a unique opportunity to be first to market with new revenue-generating services.

The discussion about customer loyalty has focused essentially on churn. Service bundles have helped carriers reduce churn and therefore improve operating efficiency. With IMS-based networks and services, the debate can shift to customer loyalty, which results from lifestyle communications environment. IMS-based services are “brought” directly to the user, on the device and method of access of their choice, in a manner that is simple, seamless, personal, portable and secure. The user accesses all the services and applications with a single sign-on and these services and applications find the user whenever and wherever they are needed. It is clear that the first provider to deliver this environment will gain the loyalty of the customer who is unlikely to seek any other experience anywhere else.

Deploying the IMS architecture gives a service provider the opportunity to be first-to-market with a range of services that are customizable to specific localized market requirements. In a market where multiple players compete for the same customer, early market entry and service flexibility can produce market share and profitability.

Early market entrants have the advantage of capturing the early adopters and technology savvy high-end customer segments, where they can maximize their profits. Service providers who are late to deploy the services face greater competition, will have higher acquisition costs, and increased price pressure resulting in lower profitability. With IMS, a service provider can substantially reduce the time required for deployment, standardization, integration and testing of every new service before it can be launched, thereby allowing an operator to introduce services more rapidly.

IMS can enable new converged and existing services for subscribers using wireline or wireless access. This will increase value to end-users. An IMS-based network adds further value through blending of services that may be available currently as separate services. For example, a subscriber could simultaneously have web portal-based management of personal call features and policies, presence capability to detect the availability of individuals on the subscriber's contact list, and the ability to share a video clip with the contacts while discussing it with them, regardless of their type of access.

Value Proposition

The value proposition for this scenario shall contain the following elements:

- An inherent enabler for fixed/mobile convergence with single set of services that apply network-wide. It is composed of one network that supports multiple access technologies;
- A flexible bundling of revenue-generating, rich multimedia services, as it allows applications to add/drop media components, invite or disconnect communications parties, and access a wide range of service capabilities (location, presence, charging, instant messaging, conferencing, etc.);
- An enhanced E2E QoS support and security for the standard IMS architecture. These key features will provide important benefits for the Network Operator;
- The basis for the fast development and deployment of many innovative multimedia services;
- An open and well-specified interface that will limit interoperability issues and allow rapid take-up.

The Network and Service Providers will also get important benefits. Here, Service Providers can expect operational efficiencies from no longer having to deploy services and applications over separate networks to reach subscribers. Taking into account the extension that the Network Operator exploits its IMS network to deliver converged fixed-mobile service bundles, it potentially will:

- Extract greater average revenue per user (ARPU) from subscribers who are enticed to add on additional services, i.e., who upgrade from their current single, or double-play subscriptions to triple and quad-play bundles;
- Reduce the loss of subscribers who, otherwise, would have switched to another service provider. As documented by market researchers observing that, an household subscribers is available to use and contract more services from a single provider, which show their propensity to considerably churn reduced (Schmidt and Kamarga, 2006).

Finally, and perhaps most attractive, the IMS framework will enable altogether new applications, and new revenue streams, which are not economically or technically viable if executed through non-IMS approaches.

Communication and Distribution Channels

Network Operators and Service Providers are looking together for new sales, distribution, marketing and advertising channels. They want to improve their source of revenue and attract new customer segments.

The conventional channel to market for content providers has been via a network operator, who decides how the content is offered, presented and priced. But this is changing rapidly and content providers now have direct ways of engaging with their target audience. It follows now that a major question for network operators is how they can incorporate off-portal content successfully as part of their next-generation data strategy, built around personalization, rich content and a more converged user experience.

Operators have, until now, been reluctant to support the off-portal proposition, since it threatened to dilute their own premium content revenues. But more recently many network operators have realized that they cannot provide the range of content and media required to satisfy all subscriber market segments. The need to attract customers from new markets has increased as the growth of the traditional mobile and fixed markets has slowed. Getting new media and content services to market faster is also a major requirement for the Network Operators, considering that the faster a new service or application can be offered, the more revenue is generated and profitability can be achieved sooner.

The Network Operator can address these issues by changing the relationship with the content/service partners. The Network Operator can use an open API approach to leave most of the content and service provisioning to the content provider but uses the inherent benefits of the mobile network to provide differentiation. While requiring the operator to deploy a service delivery platform and use Web services to integrate the content from the off-portal providers, this approach allows content from a wide range of providers to be offered to the subscriber base. The use of open APIs also requires the mobile operator to enforce service level agreements with each content provider to ensure quality and consistency (IGR, 2006).

It's certainly true that the emergence of off-portal activity reduces the power of network operators, but it also presents them with opportunities to capture a slice amount of the content market by facilitating transactions and payments through their existing billing and payment systems. Besides that, there is an opportunity for network operators to generate increased data revenues by charging for airtime and packets consumed, rather than the content itself.

Customer Relationships

One of the biggest challenges of a Network Operator is to improve customer retention and profitability. This can be achieved by improving the efficiency and responsiveness of processes, such as order processing, billing and customer service, and by enabling shorter time to market for high-demand services.

The service level convergence allows carriers to rate and/or bill any type of service in the same system with a single point of management. It also enables the possibility of offering multiple services and charging or billing a user with a single invoice or from a single prepaid account. A customer receives a single bill or uses a prepaid account for many mobile and non-mobile services, such as voice, content, parking or ticket payments. The user may also check his account status and services history using a single self-care application.

At the same time, the Network Operator shall consider a way to increase the speed and effectiveness of after-sales maintenance and repair services. This can be done using a self service strategy. Customer self service represents a genre of service management applications, which enables end-customers of an enterprise to “help themselves” in accessing information, assistance, products or services from the enterprise. A customer self service application can yield significant benefits:

- In the absence of self service, the help desks and call centres of organizations can get flooded with requests, whose complexities range from a simple, routine query to a complicated break-fix of equipment. However, an important amount of categorizing requests could be very well served by self-help features such as FAQs, online assistance, troubleshooting knowledge-bases, etc. Therefore, Network Operators could potentially free up their service & support personnel to focus on more involved issues that truly require personal assistance;
- When provided with the right customer experience, self service applications can keep pulling customers back to the company web sites, thereby enhancing brand loyalty and customer retention. It also enables Network Operators and Service Providers to cross-sell products and services;
- The potential for online assistance & process automation in self service applications could significantly reduce costly field visits and speed up resolution times.

Key Resources & Key Activities

Here, we present a concise set of key resources available at each entity and the major activities that shall be performed by these entities.

1. Network Operator

- Technical competences in the fields of management and marketing;
- Brand image and reputation;
- Billing solution (based in time used or applications access);
- Internet presence and acting as a communication channel;
- Direct relationship with customers;

The Network Operator is responsible for the commercialization of all-featured solution and to implement a billing service to account the services provided to the customers.

2. 3rd Party Service Provider / Open Source System Integrator

- Technical knowledge in specific technologic domains;
- Specialized human resources;

The 3rd Party Service Provider is responsible to provide technical solutions and services in their business domain and to establish a close relationship with the Network Operator. In this scenario, several 3rd Party Service Providers can exist, which are responsible to provide “best-of-breed” solutions in the domains of gaming, location based applications and real-time communications for the Network Operator.

3. Open Source Support Services Provider

- Specialized technical competences;
- Specialized resources in the security field;
- High specialized human resources;

The Open Source Support Service Provider is responsible to develop specific Open Source Solutions to be provided to the Open Source System Integrator. Also, the Open Source Support Service Provider can enable equipment manufacturers to meet existing needs and prepare for future ones in the IMS market.

4. Open Source Provider

- Scientific and technical competences background;
- R&D projects and motivation to be involved in such kind of projects with a strong research component;

The Open Source Provider is responsible to develop Open Source projects in cooperation with other developers around the world.

5. Legal Support Provider

- Formation in legislation/laws and strong competences to understand the Open Source licenses;
- Knowledge of telecommunications regulation;

The Legal Support Provider is responsible for juridical advisory.

6. Quality Certification Entity

- Competences in the domain of quality management;
- Independence and impartiality behaviour.

The Quality Certification is an independent entity which is responsible to evaluate the software provided by the Open Source System Integrator entity.

7. Training Provider

- Certification of competences of their employees;
- Regular internal formation of their employees;

The Training Provider entity is responsible for the formation of human resources at the 3rd Party Service Provider and to the Customers.

8. Open Source Consultant

- Experience of their employees;
- Flexibility and adaptation capacity of their human resources;
- Knowledge of IMS and ad-hoc technical solutions;

The Open Source Consultant is responsible for providing consultancy services regarding the “best-of-breed” solutions in the IMS field. It also have a good vision about the future tendencies in new technologies and about best business applications in the area of 4G networks.

Revenue Streams & Cost Structure

Here, we present the most relevant revenues and expenses for each entity following the proposed scenario.

The most important revenues of this scenario are the data transport incomes and services accesses that the Network Operator gets from the customer. The services access to the platform can be billed based in a period of access, number of accesses or facilities used by the customer of the platform. Also, the 3rd Party Service Providers receive important incomes from the Network Operator based in the kind of services or platform that they offer to the Network Operator.

On the other hand, the most relevant expenses of this scenario are the technical infrastructure that the Network Operator needs for offering its services and maintain a communication channel with the customer. Also, the Network Operator will need to pay for the services/application provided by a 3rd Party Service Provider.

In table 15 we show the major revenue streams and cost structure for the entities of this scenario.

Table 15: Major revenue streams & cost structure of scenario III

Network Operator	
Revenue Streams	Cost Structure
Data transport incomes	Human resources
Services access to the platform	Technical infrastructure

Creation of Value with OS Software in the Telecommunications Field

	Internet portal
	Paid 3rd party services
3rd Party Service Providers / Open Source System Integrator	
Revenue Streams	Cost Structure
Services/applications provided to the Network Operator	Human resources
	Services paid to other entities in the “model”
Open Source Support Service Provider	
Revenue Streams	Cost Structure
Selling support services	Human resources
Selling high-tech advanced functions in terms of security and high-availability	Services paid to other entities
Open Source Provider	
Revenue Streams	Cost Structure
Knowledge and status inside the OS project	Consumption of time and effort.
New career opportunities	Some minor technical infrastructure (can also be considered redundant)
Legal Support Provider	
Revenue Streams	Cost Structure
Consultant services	Human resources
Quality Certification Entity	
Revenue Streams	Cost Structure
Based in the certification's type	Human Resources
	Certified fees (applied when 3rd Party Providers include propriety software)
Training Provider	
Revenue Streams	Cost Structure
Based in each formation provided to the their customers	Human resources
Established contracts with 3rd Party Service Providers entities	Technical material
	Investments in continuous formation

Open Source Consultant	
Revenue Streams	Cost Structure
Consultant services	Human resources

Partner Network

For a Network Operator, the best way to create a valuable service is likely to include exploiting features and knowledge obtained from other services offered from 3rd Service Providers. Administrative and customer acquisition costs are paid on a per-customer basis, and if the customer has been obtained anywhere or became a customer through any service or channel available to the network operator, it is critical to fully leverage the relationship.

This typically involves more than simply attempting multi-service up-sell. It involves creating cross-service symbiosis. The symbiosis can both lower operations costs and raise average revenue per user (ARPU), creating a double-win situation.

The classic example of cross-service symbiosis is the fixed-mobile convergence (FMC). While the name suggests that the primary goal of FMC is infrastructure reuse, the current market mindset is that the greatest value lies in the ability to create more valuable voice services by creating a unified voice services that can be projected through fixed, mobile, or both avenues to the user.

The new valuable services that a Network Operator can offer to the customers are dependent of the partnership agreements with 3rd Party Services Providers. In this scenario we consider fundamentally the following services domains:

- Location Based Services (LBS);
- Mobile Gaming;
- VoD/IPTV Services.

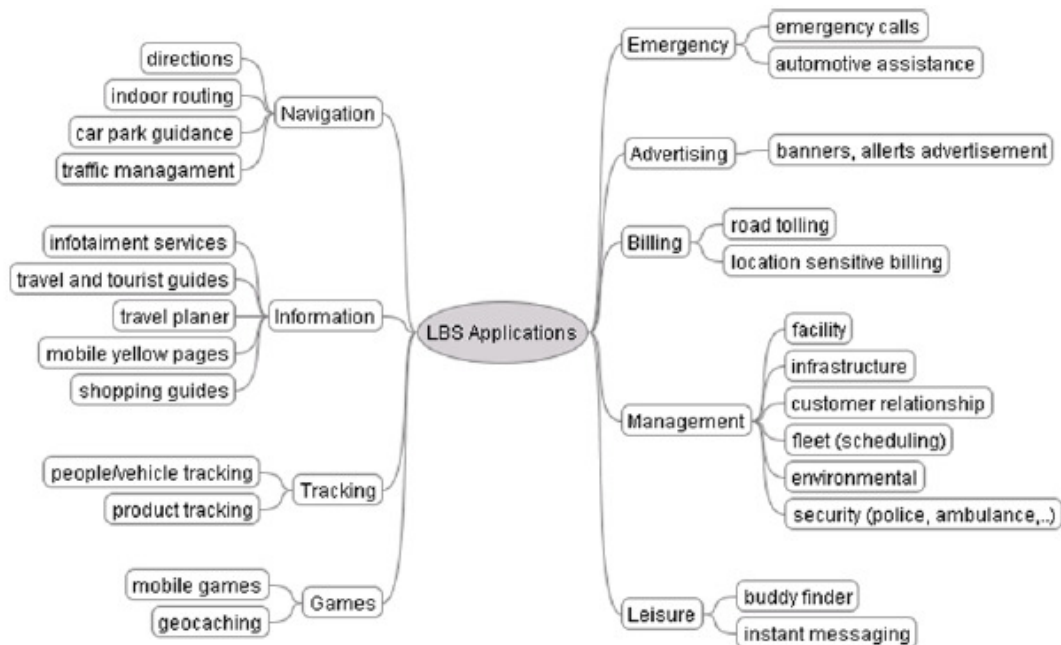
In recent years, location has acquired a completely new dimension through the introduction of a special group of telecommunications services that explore location awareness. Location-based services (LBS) have become one of the most prosperous groups of emerging telecommunications services. In their essence, location-based services successfully integrate three basic building blocks: positioning systems, (mobile) communications systems, and location content.

The notion of location in an IMS framework plays a pivotal role in terms of enabling services. Location is critical for identifying and capturing subscribers that are roaming in and out of different mobile switching centers and different networks. It plays a very important role in understanding where you are on the network and how to extend the available services, and will enable all the services, no matter where the user is in the world.

IMS also promises to deliver more contextual solutions that not only determine a user's location but also which types of applications best complement that particular setting. It will

also enable LBS to work in concert with emerging multimedia technologies to deliver information in a more compelling manner.

Figure 71: LBS application categories



Source: Steiniger, Neun and Edwards, 2006

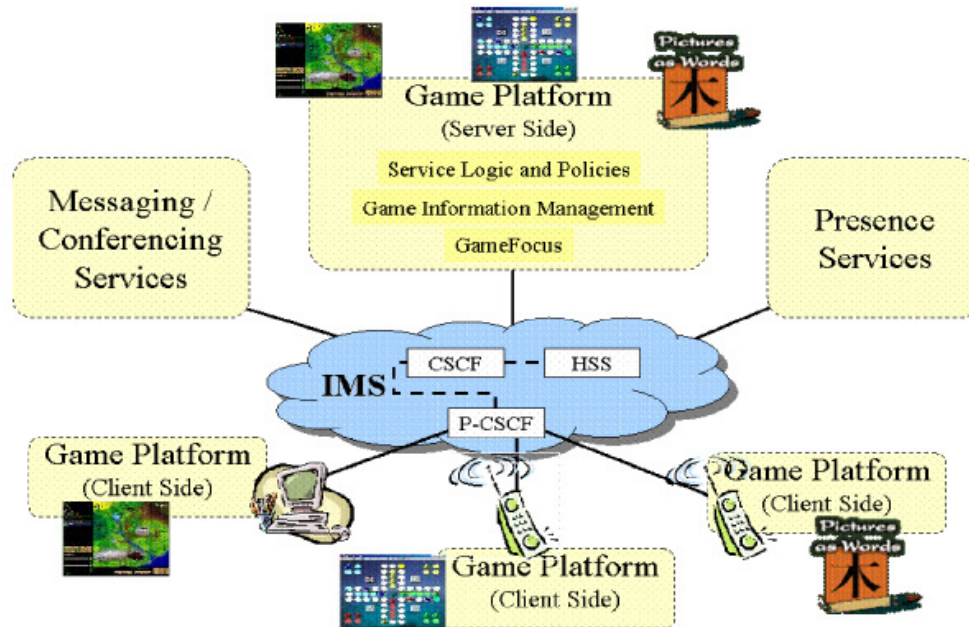
Presently, the Open Source Consortium, which is a non-profit organization that is leading the development of standards for geospatial and location based services, specified an Open Location Services Interface Standard (OpenLS). This interface enables companies in the LBS value chain to provide their pieces of applications, such as emergency response, personal navigator, proximity service, corporate asset locator and geography voice-graphics (see figure 71).

Other partnerships can be established between Network Operators and 3rd Party Service Providers that offer new generations of gaming applications through mobile devices. Nowadays, mobile devices offer the opportunity to play games nearly everywhere. Moreover, networked games allow individual players to interact with other people and to participate in a larger gaming world, which also provides for new business opportunities.

Until recently, most games were stand-alone applications designed for a single player. This has changed lately, where many games are directly towards a multi-player scenario where people can interact and compete. Today, most of these networked multiplayer games are developed for PCs connected to fixed networks. Multiplayer games can be distinguished by their flexibility with regard to location and network connectivity. In online multiplayer computer games and console games the players are usually connected via a fixed line network and thus quite restricted for choosing their location. Players on mobile handheld devices have more flexibility: they can play in different locations and/or networks. Also, we must consider that games developers, providers and players get more and more interest in games that can be played everywhere. Thus, games must be available on mobile devices.

The 3GPP IMS architecture is the perfect architecture for mobile Internet games. This technology combines two of the world's most powerful innovations: the Internet and wireless communications. The Institute of International Business Relations of University of Berlin in consortium with NEC Laboratories Europe proposed a gaming platform for game services over IMS, which is depicted in figure 72.

Figure 72: Framework proposed for game service over the IMS



Source: Akkawi, Schaller, Wellnitz and Wolf, 2004

This framework allows using the IMS capabilities (e.g., presence, messaging, QoS), but also may offer additional functionalities that every game needs (e.g., player and game management). The platform API is used on both client and server sides of the game, but with different functionalities.

Other partnership can be established between Network Operator and IPTV/VoD services provider. At the present time, IPTV (television service over IP networks) and Video on Demand (VoD) provided by telecom service providers is starting to compete with existing broadcasting services via terrestrial, satellite and cable networks. Increased broadband network bandwidth, enhanced compression techniques and new distribution architectures have made IPTV/VoD technically feasible. Even more significantly, the marketplace is increasingly demanding new digital content and telecommunications service providers are seeking new growth areas.

An IPTV/VoD service provider can include the following service components:

- TV Services – Broadcast video content at a fixed time schedule like traditional television. Customized, packaged choice of channels, might include public TV channels, “pay TV” channels, special interest channels, shopping channels, etc;

- VoD – The delivery of chosen video content is initiated by the user at a time of his choice. Typical contents are movies of recorded films chosen from a library;
- Personal Video Recorder (PVR) – A PVR is a consumer electronics device that enables broadcasted video content to be recorded and viewed at a later time;
- Electronic Program Guide (EPG) – As the name suggests, a guide to provide the user with information about the current and upcoming IPTV programs;
- Information Services – Information services might include news, sport news, weather forecasts, local content (flight information, train information, event information, etc.) and more;
- Interactive TV – The IP “back channel” does not only provide the possibility to retrieve information, but also allows to interact with TV shows or to initiate applications linked to the running program. Typical examples of interactive TV are participation in quiz shows, voting, viewer feedback, commerce, etc;
- Interactive Applications – Interactivity does not have to just be linked to a traditional TV program. Gambling, auctions, shopping and banking are known applications that may also conquer the TV screen given the convergence of devices and development of new user interfaces.

One recent initiative founded in March of 2007 by some of most network operators and service providers companies, such as Ericsson, Nokia, Siemens and Sony Corporation, is the Open IPTV Forum. It is a pan-industry initiative created with the purpose of producing end to end specifications for IPTV that will take the next generation of IPTV into the mass market. The Forum, which is fully open to participation from the communications, entertainment and other relevant industries, focus on the development of open standards that will help streamline and accelerate deployments of IPTV technologies, and maximize the benefits of IPTV for consumers, network operators, content providers, service providers, consumer electronics manufacturers and home and network infrastructure providers.

The Open IPTV Forum founding members are Ericsson, France Telecom, Nokia Siemens, Panasonic, Philips, Samsung Electronics, Sony Corporation, and Telecom Italia.

The Network Operator can also establish other partnerships with other service providers, independently of the kind of value-added application that is offered to its customers. We can consider the following partners:

- Subscriber management solution providers;
- Manufacturers;
- Advertisers.

Establishing a partnership with a subscriber management solution provider can be important to incorporate enriched media and subscriber management in end-to-end IMS networks and applications for mobile, integrated fixed-mobile and multi-play operators. As a result of this collaboration scenario, subscribers would enjoy converged voice, video and messaging services, as well as data management. These enriched capabilities will enable operators to capture a greater share of subscribers' total communication and entertainment needs.

A major area of concern in IMS deployments is the capability to work with different equipment manufacturers. Customers want the ability to link through different equipments provided by several companies. However, with undefined standards, interoperability among different vendors with varied perspectives can be particularly frustrating and this partnership can facilitate the integration of several applications. Moreover, with IMS likely to be involved in new services such as voice and video deployment, delivering such services in an efficient manner will create many opportunities for vendors in the IMS test and monitoring equipment market space.

Finally, the advertising market can be used as a complementary business model for this scenario. Advertising can be tied to free or discounted calls and free content delivery. Various innovations can be used with this scenario, namely:

- Real-time advertising insert for content delivery;
- Advertising firms bidding real-time for search/discovery ads (Yellow page model).

7.4.4.3 Model Assessment

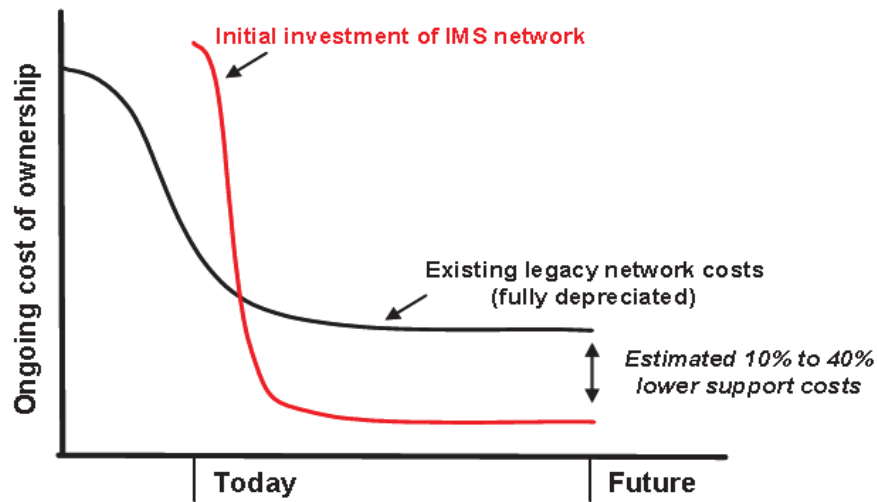
In a first instance to assess the viability of the application of the proposed framework to this scenario we will conduct a SWOT analysis.

Strengths

- Development community and programming expertise – several applications can be found in the Open Source community and can be integrated in more advanced IMS full-featured solutions. These applications receive a lot of participation from several external entities, especially students and university/R&D staff;
- Decreased time-to-market – the standardization of both the communication protocol between the different elements and also of the interfaces and functions provided by the common services significantly reduces the time-to-market for rolling out new IMS services and provides to Network Operators the freedom to experiment with new differentiated services. Application developers are no longer hampered by multiple integration and deployment efforts. They can cost-effectively integrate their services into an operator network and immediately release them to end-users;
- Lower costs – the proposed IMS architecture describes common services (e.g., services related with charging) that can be used uniformly by all the applications requiring that specific function. The communication between the different components (end-users/services) in the IMS infrastructure is based on open and well-defined standard protocols, such as SIP. This significantly reduces the complexity of the systems decreasing CAPEX and OPEX, especially in a complex service environment where a large number of services have been deployed. Operators only need one infrastructure to support all type of multimedia services;
- Value chain control – IMS was designed to be “operator centric” and enables Network Operators to open up their networks to third party developers without sacrificing control of their networks or their value chain. Operators will not only control the

network access but also the management of multimedia sessions, the application and services provided, the charging and the content, while still being able to selectively delegate the development of new applications to third parties;

- Best of breed of applications – this framework gives to the Network Operators the flexibility of selecting the “best of the breed” component from a vendor rather than being locked in with one or a limited number of them. In addition, this becomes even more attractive as interoperability and inter-networking issues are minimized with the use of open interfaces and standards;
- Integrated and interoperable services – the IMS infrastructure offers open and standard interfaces to 3rd party application developers for creating new sophisticated and attractive bundled multimedia services. Services will be easily, transparently and inexpensively integrated in the Operators network by using common enablers, such as charging systems, thus significantly reducing integration issues. Also, the use of open standards promotes interoperability and inter-networking between Operators’ networks. This will facilitate the adoption of services in the user community as they will be able to communicate using multimedia services anywhere they are using the roaming and mobility capabilities of IMS and with anyone they want;
- Integrated rich media – end-users will have the ability to use more than one type of media: e.g., text, audio or video in a single call. Additionally, they can easily convert one-to-one sessions to one-to-many sessions and back to one to one without having to terminate and re-establish sessions;
- Single public entity – the user has to use only one external identity for all the services offered by the Network Operator, as the IMS infrastructure is able to hide the internal usage of different application-specific private entities;
- Less expensive support – maintaining today’s complex networks requires complex monitoring and support tools. Likewise, the training to maintain the specialized skill sets required to support the networks can be costly and time consuming. Moving to commodity networks and common protocols of IMS will ease finding maintaining the skill sets necessary for network support;
- Lower maintenance costs – older equipment prevalent in today’s typically network carriers have heavy maintenance costs, despite being paid for and depreciated. Additionally, some of the software in use today is no longer supported by the original vendor, which brings additional support issues. Newer equipment and systems, even after taking into account initial purchase costs, have a short term payback period due to significantly lower support costs.

Figure 73: Estimated legacy vs. IMS network support cost savings

Source: Grilli, 2006

Attending to the figure 73, we can consider that in many cases, maintenance costs for new hardware and software components can be 10 to 40 percent less than existing equipments, which puts the IMS network on a more favourable curve.

Weaknesses

- Dependence from several entities - there are several players in the market and the complexity of coordination between them can be huge, particularly between Open Source Consultant, Legal Support Provider, Quality Certification Entity and Training Providers with the 3rd Party Service Providers or Open Source System Integrator;
- Difficulty of technological implementation – the IMS architecture contains many extremely stateful protocols with lots of optional features, making it easy for implementers to make mistakes;
- Security issues – IMS runs over a variety of transport protocols, and that expands the product and network services attack surface. We can consider that IMS and SIP are appealing to attackers because they are key enablers of many types of presence-based services. By exploiting SIP, attackers can misuse presence-based applications to bypass traditional perimeter network defences and cause digital misbehaviour;
- Difficulties to measure the customer's QoE – the IMS architecture promises QoS-enabled applications, as well as differentiated service support based on application QoS requirements. Measuring the QoS being delivered to a customer is challenging enough when we are dealing with lost or delayed packets or when we have multiple networks connected together. But measuring the customer quality of experience (QoE) is even more challenging.

Opportunities

- Lower risk profile – with IMS, new applications can be introduced with minimal deployment time, effort and expense, therefore the payback period is shorter and the risk of launching new services will be minimized;
- Less churn – customer loyalty increases when one operator can deliver lifestyle voice and data services and when the customer has access to new applications and services with no delay and no interoperability concerns. The proposed architecture enables rapid service creation via simple modular elements, therefore the result is faster time to market and satisfaction of consumer demand;
- New revenues from Fixed-Mobile Converged (FMC) bundles – FMC bundles not only deliver core services (i.e., voice, wireless, high-speed data, and video) to quad-play subscribers. They also deliver new and incremental sources of value beyond billing and single-number simplicity. Commonplace features associated with core services become more beneficial to the end user when they become available in other domains, especially when the extension of the features is seamless and does not require much, if any, additional effort or learning from the users to experience them;
- Increasing branding value – with IMS and FMC, all user communication and entertainment needs can be integrated into a personalized, seamless user experience, increasing customer satisfaction and loyalty. Services can be personalized easily and mixed and matched by the user. Mass-market customization will lead to more brand value;
- Attractiveness for the participation of Universities and R&D centres – universities and R&D centres with advanced knowledge in the fields of networking and telecommunications can participate in this scenario as a 3rd Party Service Provider or as an Open Source Consultant entity;
- Suitable for start-up companies – this scenario facilitates the participation of technologic-based start-up companies as a 3rd Party Service Providers. Besides that, this model encourages the creation of start-up companies as spin-offs of R&D centres and universities.

Threats

- Standardization fork – all the major standards groups are working to harmonize IMS standards. However, all of these standards groups are supported by different telecoms (or divisions within a telecom), each is going after the same customers, and all want service differentiation. So, it will be possible to appear a kind of IMS forking, originating dozens of different IMS networks (Lucas, 2006);
- Lack of IMS devices – the lack of handsets that support IMS services is just one of several challenges hindering wider adoption of the communications platform. According to Dean Bubley (senior analyst at Disruptive Analysis) the telecom industry seems to have underestimated the complexity of getting the phones out in the market right before investing billions on new infrastructure (Bubley, referred by Tan, 2007);

- Network Operator resistance – IMS services could also threaten existing revenues from SMS, which could contribute between 6 and 15 percent of an operator's revenue. Actually, "the amount of revenue you can earn per SMS is fairly high but if you're going to deliver instant messaging, you'll start to move from SMS carrier to a data-based carrier, of which the revenue is significantly less;
- Lack of well-established financial model – there is an uncertainty over how operators should charge subscribers in an all-IP network. When we move to a data-based application, where we try to connect between a fixed and mobile network, a charging mechanism might be considered, because the reception of the call is consuming data;
- Decreasing the overall quality of services – at the same time, the more services that are provided, the greater the chance for decreasing overall customer satisfaction because some of those services could be poor in quality. Also, the free trial services can degrade the overall QoS and thus the paid critical services;
- Competition against free services (portal voice, video, etc.) – the Yahoo and Google portals and e-commerce companies like eBay don't need IMS, nor do they need voice or video payments from their customers. In this Internet ad-based world, services are given away for free (such as Skype by eBay) to attract people. Making IMS networks compete against free can be a tough business proposition.

Following the Osterwalder model, we will consider some pertinent questions to evaluate our proposed framework.

The first question is a typical issue that we already considered for the two previous scenarios. We will analyze if the Network Operator knows its customers needs good enough and which are the features that telecom users want to have available in the market.

The second question looks to the traditional telecom competitors and will also analyze how IMS can replace this traditional approach. We will analyze how IMS will enable operators to realize the vision of a subscriber-centric world with independent services access.

The third question tries to evaluate the partnership between Network Operator and the 3rd Service Provider. We will analyze this issue taking in consideration the level of integration between these services, such as LBS, mobile gaming and VoD/IPTV in a IMS architecture.

1. Does Network Operator know customers' needs well enough?

User and enterprise needs will drive multimedia service evolution for both mobile and fixed operators. Users expect to be able to do more with their communications services, for less money, and are showing an interest in services beyond voice. They are attracted by services that offer them access to a wide range of communications information and entertainment services in a user-friendly, cost-effective way. Users want to customize the experience of all their interactive services to meet their own particular unique circumstances, their lifestyles and their preferences (Lenahan, 2008).

Today's telecom users are increasingly demanding. They are more individualistic, independent, informed and involved than ever before, and they welcome services that appeal to their emotions as well as their practical needs. New, exciting services and enhancements to existing services have a key role to play in making the communications experience much more like interacting face-to-face. New advanced terminals and communication mechanisms adapted for user needs will enable this and hide technical complexity.

Telecom users are essentially looking for three kinds of benefits:

- Richer user experience – Users are now used to accessing information, entertainment and other content-rich services through a variety of channels. Telecom operators have a great opportunity to integrate and extend the multimedia experience through new highly personalized person-to-person, person-to-content and group services;
- Convenience and ease of use – Any new service has to be natural and intuitive to use if it wants to be a mass-market success. Today's subscribers are used to mobile and fixed phones anywhere in the world to call anyone. Similarly, they will expect new services to offer a seamless experience across multiple access technologies, devices and locations, whether wireline or wireless. The user experience should also be consistent across different device types;
- Safe communication – Telephony services have always been reliable and largely immune from curses of intrusion, viruses and spam attacks that have come to characterize the Internet. IP-based multimedia communications services must be safe for people to use, free from malware or malicious attacks, whether through their mobile or fixed terminals. Users will also want reassurance that others cannot gain unauthorized access to their personal services and information.

At the same time, the enterprise market is always chasing costs and pursuing ways of running their business more efficiently to improve the bottom line. Enterprises want to have control and will demand flexibility in the way they handle their communications, such as moving, adding and changing user information.

Enterprises are made up of individuals who have the same needs as typical end-users. However, there are some requirements that are specific to, or more apparent in, the enterprise world. Those needs are tailored to their work group or work environment.

New technologies are enabling new more flexible ways of working. For example, the remote worker is a relatively new phenomenon but is becoming more commonplace. Working from home, at airports or on the road is very convenient when one has access to the same services as in the office, including buddy lists, presence and stored information. It should be possible to reach remote workers using a single name or number, regardless of location or access device.

With the growth in distance working and international business relationships, enterprise users need intelligent ways of bridging the distance with smart tools like collaborative working and file sharing. Discussing a document or a presentation remotely should be as natural as if both parties were sitting in the same conference room. With the emerging needs of working outside the company premises, security is an important requirement mainly from the IT

departments. The employees need to have secure access to functionality in the IT environment from their mobile devices and the provisioning and management of applications need to be done in an efficient and secure way.

Enterprises, in particular large enterprises, need interoperability with their legacy systems, such as their telecom communication system and IT environment. They want to migrate from the systems they have into new IP and SIP based functionality comprising telephony, messaging, presence, conferencing, collaboration, etc.

2. How well are customers served by traditional telecom competitors and how can IMS replace traditional approach?

Traditional telecom sources of revenue are based exclusively in voice and data revenues. They also use a closed-source software model, with no communication between different applications, making it very difficult to deploy an integrated billing system. Besides that, the complexity to manage these services is huge, from the operator and user point of view.

The continuous evolution of technology is also creating challenges for service providers. The emergence of Internet Protocol (IP) promises new options, significant savings in CAPEX and OPEX and opportunities to develop and bring to market services and applications previously not possible.

While network technologies are evolving, the biggest barrier to increased service adoption is that the user experience does not meet consumer expectations. The services and user interfaces are too complex and time-consuming to use, creating frustration and limited penetration. It is significant that the two most successful services in the history of telephony have been voice communications and basic messaging, both of which are intuitive and simple to use. Valovic considers that one of the biggest challenges that carriers presently face is making their networks and network services more agile. He also says “they have to move closer to an Internet business model for their end-users who are used to a lot of flexibility and control when they use the Internet” (Valovic, 2007).

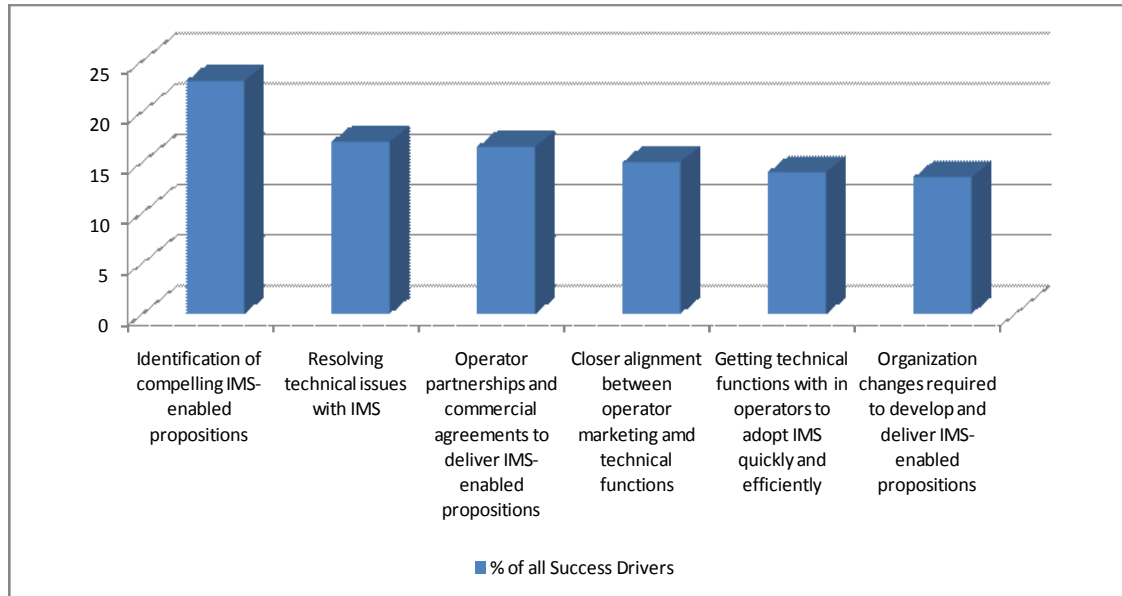
This problem cannot be solved simply through the service provider’s legacy infrastructure. With a traditional network structure, any new service which an operator wishes to offer requires its own infrastructure. This means the operator must replicate the hardware, software, telecommunications middleware, application enablement, provisioning, billing and operational management for every service that is launched. This siloed approach significantly lengthens time to market and is expensive as network elements cannot be reused for another service. The customer also suffers as each service behaves differently, increasing user frustration and reducing mass market adoption of new services.

The resolution for many of these problems lies in the evolution to the IMS architecture. IMS will enable operators to realize the vision of a subscriber-centric world with independent services access. Service providers will be able to enhance the communications experiences by allowing the end user to integrate every kind of media (voice, video or data) using any

network. IMS will also enable the creation of blended services built with multiple atomic services, such as messaging, push to talk, push to share and interactive video.

A recent survey performed by IMS insider points to the major success factors for IMS (see figure 74).

Figure 74: Success factors for IMS



Source: IMS-insider.com, 2008

Attending to the figure 74, we can realize that the most successful factor considered is the kind of applications that IMS will turn viable. It's still an open issue, but in this thesis we presented three kinds of service domains that an IMS solution shall attend, namely: location based services, mobile gaming and VoD/IPTV services. Another concerning point is the technical issues regarding the IMS technology, namely in terms of security, service interoperability and quality of service. Another important point to address is the partnership agreements between the Network Operator and the 3rd Party Service Providers.

3. How to evaluate the partnership level with 3rd Party Service Providers?

For this scenario we considered fundamentally the following partners agreements:

- Location Based Services (LBS);
- Mobile Gaming;
- VoD/IPTV Services.

A good way to evaluate our partnership with these 3rd Party Services Providers is to look to the level of integration between these services in a IMS architecture. Currently, telecommunications service companies are being “pushed” in the direction of convergence by market pressure, competitive pressure, technological change, and the search for new growth. They are being “pulled” in the direction of convergence by the increasing of IP networks and the exploding demand for new digital content and applications.

The convergence has many facets and among them are:

- Convergence of devices – The use of different access devices like telephone or personal digital assistant and gaming platform or PC should be transparent to the end user;
- Convergence of telecommunications networks – The merger of IT and telecommunication provides a greater variety of applications, access options, devices and content;
- Convergence of media and content – Every media content, such as voice, text, video and audio is being enabled on today's IP networks and devices. Users may be able to access any kind of multimedia content according to their individuals needs, like music, games, TV shows or rich information;
- Convergence of services and applications – The triple play bundled offering of video, telephony and broadcast Internet access provided over a single IP network is already a reality provided by some companies. The next step is the “quadruple play” that adds mobile telephony to the triple play;
- Convergence of tariffs and pricing models – Parallel to the convergence of services and applications, tariffs and pricing models are also converging. An example is a “home zone” tariff of mobile operators which allows users to call and be reached at fixed networks prices when they are at home. Another example is the combination of DSL and public WLAN (Altgeld and Zeeman, 2008);
- Convergence of industries – The boundaries of the Telecommunications industry, of the Media & Entertainment industry, of the Information Technology industry, and of the Consumer Electronics industry are blending in parallel to the convergence of the dimensions described above. Traditional Media & Entertainment companies like TimeWarner, with its traditional core content business (production, aggregation, packaging of films, music and entertainment) are moving along the multimedia value chain in the direction of service provision and transport (Altgeld and Zeeman, 2008). On the other hand, telecommunication companies, with their strong capabilities in network transport and customer management, are moving in the opposite direction towards value added content services, like provision of music downloads, games and films.

7.4.4.4 Model Innovation and Improvement

Attending to the Osterwalder model, we will consider some key questions to look for some improvement paths that entities of our proposed framework can adopt.

The first question tries to find an approach to improve the customer experience and, at the same time, stimulate the usage and loyalty. We will not only try to understand how these consumer groups value, access and use content, but also we will see how we can build new propositions that target these users.

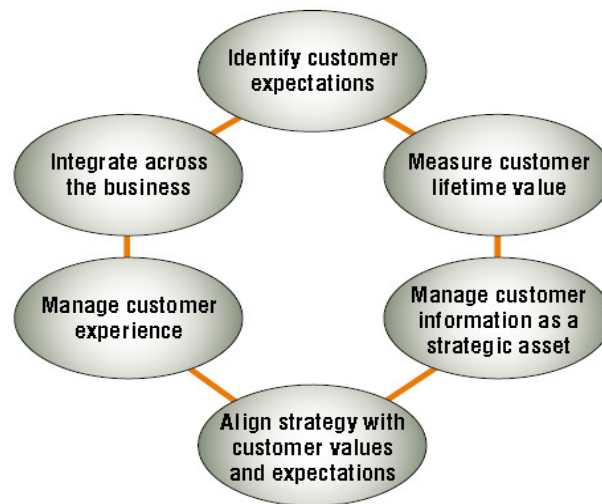
The second question tries to find a way to introduce new revenues streams. We considered a situation where IMS services can be used in business models that mix paid communication services and publishing/advertising in their Web 2.0 business strategies.

The third question presents a strategy to manage and reduce risks in an IMS business approach taking in consideration the internal barriers to innovation and the misunderstanding end-user needs and their evolution. A well established managed risks methodology will let the Network Operator avoid situations, such as lost opportunities, spoiled investments, offended shareholders and lost customers.

1. Is it possible to offer to different customer segments more tailored services?

Developing a greater customer intimacy can help telecom service providers to differentiate the customer experience, as well as to stimulate usage and loyalty. Improving the customer experience requires attention across all stages of the customer journey, including awareness, acquisition, growth and retention.

Figure 75: Staging the customer management process lifecycle



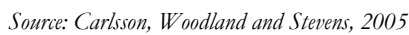
Source: Carlsson, Woodland and Stevens, 2005

The elements of customer lifecycle presented in the customer management process diagram presented in figure 75 are the following:

- Awareness – clear brand values must be identified for different target segments to inform innovative marketing and product awareness campaigns;
- Acquisition – retail shops, web sites and multi-channel contact centers are all critical customer touch-points that can provide opportunities to differentiation;
- Growth – network features and the provision of innovative devices and services are already critical operator battle grounds for revenue stimulation and provide scope for further differentiation;
- Retention – billing and online payment, customer care, marketing and other communications also present opportunities for an improved customer experience.

Customer segments are quickly evolving as customer needs become more distinct. Service provider offerings shall match the connectivity needs of their customers' lifestyles.

Figure 76: Major needs of evolving consumer segments



SMEs represent a lucrative opportunity for telecom companies. However, the disparity of SME size, revenue potential and technical expertise make it more difficult for large telecom providers to sell directly to this segment than to large enterprises. SMEs requires reliability, flexibility of service and responsiveness to their business needs. Value for money is more important than simple low costs. Above all, SME customers want to be treated in a manner that reflects the reliance they have on telecom services for their own businesses to succeed.

In contrast, many big businesses look to telecommunications as a necessary business tool, but also as an opportunity for reducing costs. In this context, the telecom industry must shift the focus from cost reduction to productivity improvement in order to succeed. Thus, convergence between telecom and IT services offers a very significant opportunity to develop

applications targeted to the large enterprise that use converged products and services to increase efficiency and generate savings.

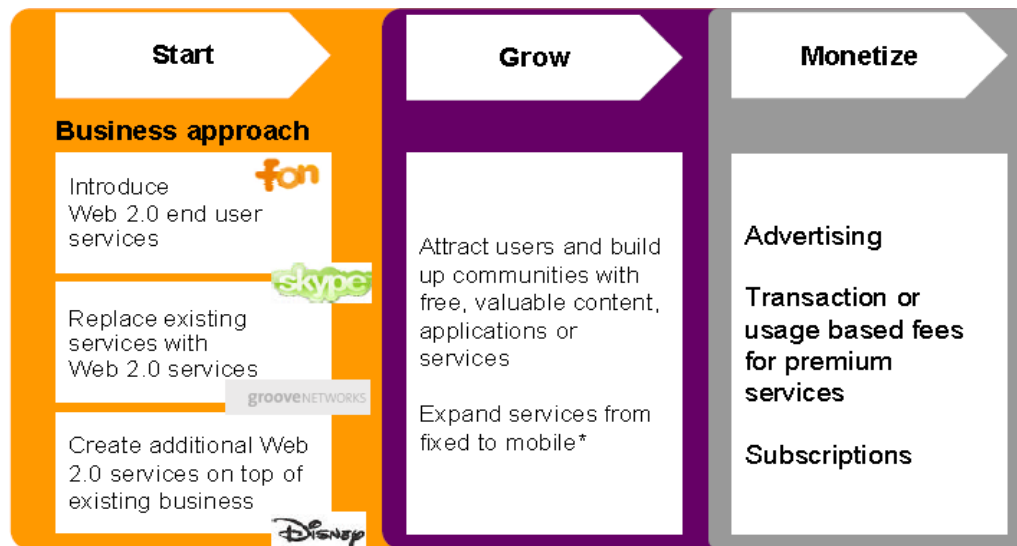
2. Is it possible to introduce new revenue streams?

Traditionally, the telecom business has used retail models, such as subscription, content, or usage-based pricing, to monetize network assets, while most profitable businesses on the Internet have adopted the publishing/advertising model (LeClerc, 2008).

IMS services can be part of the strategy of all major telecom service providers, who create their own communication services with more-or-less proprietary technologies and link with legacy services. These new players generally have business models that mix paid communication services (e.g., interconnection with legacy communication systems) and free services (that generate ad-based revenue) in their Web 2.0 business strategies. Telecom service providers can integrate IMS and Web 2.0 into their product strategy, which will give operators the ability to deploy their fixed or mobile communication services to support traditional offerings or deploy new Internet-based services.

The typical Web 2.0 business approach is depicted in figure 77.

Figure 77: Web 2.0 business approach



Source: Bottiglieri, 2007

Based on figure 77, we see that a Web 2.0 business approach tries firstly to introduce Web 2.0 services. The intention is not to generate immediate revenue, but create a large community of users. This community will attract the attention of strong brands that will realize that there is a big opportunity to implement marketing companies for this target community. Other way to get value from the community is to offer complementary Web 2.0 services based in a subscription business model.

The big point actually is not how to replace Web 2.0 with IMS, or vice versa, but to determine how Web 2.0 can help telecom operators introduce their communication services

into the web environment using their existing infrastructure and IMS (Dorbes and Amossé, 2008).

Web 2.0-based blended services create opportunities for telecom operators to embrace different business models. Legacy communication services are generally based on price/unit or on flat fees, while ad-based revenue models are popular on the Web. The right mix between these two depends on the objectives of the provider and the combination of content and communication services. By itself, the combination of IMS and Web 2.0 does not introduce new business models, but because it represents a link between two different worlds, it may introduce operators to new business models, which can stand alone or be used in various combinations. They include:

- **Wholesaling** – this occurs when a network operator resells an asset, such as excess network capacity, to a retail service provider that can be a Virtual Network Operator (VNO). The VNO then offers services to commercial institutions or consumers. The wholesaler owns and operates the access network and offers connectivity to service providers;
- **Outsourcing** – this involves transferring the management of resources and day-to-day business functions to an external supplier. These business functions range widely, for example, from billing to data storage all the way to supply chain or human resources management. The focus of this business model is to reduce infrastructure costs, to mitigate network evolution risks and to develop new services for defined customers segments. This approach will also improve time-to-market of new services that would otherwise require longer periods to be implemented internally;
- **Aggregation and Brokering** – shift from the connectivity/transport services to content creation/application aggregation activities. Broker content to multiple operators and direct user information to multiple third parties. Revenue is generated as individuals directly purchase content (such as via VoD and pay-per-view models) or sign up for subscriptions to premium content. This model can also be integrated with sponsored activities. A critical aspect of content aggregation and brokering is the ability to manage the distribution while ensuring the integrity of content complying with the copyrights of authors and editors by using digital rights management technology. By brokering content from multiple sources, the service provider can offer unique services and contribute to the top line in a revenue share model with content creators;
- **Advertising** – grow advertising-based activities by selling branded items through sponsored services. Converging networks and related services are combined with the management of subscriber profiles to offer insights into geographic, demographic and, most importantly, behavior patterns about the subscriber base. Targeted advertising models should be optimized to provide the right message to the right people at the right place at the right time. Brands and advertisers will pay a premium to service providers that can offer these types of targeted advertising services, making significant contributions to top-line revenue growth;

- User generated content and communities – this model calls for the development and deployment of platforms, tools and applications that allow any user to generate and distribute multimedia content. This content can be developed by individuals or in a collaborative environment by multiple users. After content is initially created, it can be modified, commented on or rated by other users after it is published. Common types of user generated content include discussion boards, blogs, social networking sites, news sites, trip planners, products and services review sites, photo sharing sites, as well as game sites and any other web site that offers the opportunity for the consumer to share their knowledge and familiarity with a product, topic or experience;
- Asset sharing – this model is triggered when two or more service providers that individually own and operate networks share overlapping tangible assets. The benefits of this model include the ability for service providers to realize significant cost-efficiencies by eliminating overlapping infrastructure. This allows them to reduce environmental impact and expand their coverage areas by redeploying displaced infrastructure. Service providers under this kind of agreement can reduce the TCO of infrastructure and redirect their savings to differentiate their offers with innovative services and applications;
- Fulfillment – this model is triggered when service providers leverage their established billing relationship with the end users to complete transactions and deliver services on behalf of third parties. This involves the creation of a team with content owners, producers, developers, terminal vendors and media buyers to bundle and blend media, entertainment and communication services;
- E-Commerce and M-Commerce – this model calls for extending service provider network resources to support the buying and selling of products or services over electronic systems and mobile networks. For example, consumers can use the wireless network infrastructure to extend the reach of electronic funds transfers, supply chain management, Internet marketing, online transaction processing, electronic data interchange and inventory management systems; they can pay for goods and services with their mobile phone, turning their mobile device into a “virtual credit card”. Service providers can leverage financial knowledge of their subscribers/customers to extend/contract credit limits while providing the communications infrastructures to complete an increased variety of transactions.

Each of these business models either reduces operational costs or increases the top-line revenue. Either way, they can boost margins. The business models that result in cost savings are outsourcing, wholesaling, asset-sharing and hosted services, while content aggregation and brokering, advertising and user-generated content increase the top-line revenue.

3. Is it possible to manage and reduce risks in an IMS business approach?

Understanding market dynamics and properly interpreting current trends is a prerequisite to plan future actions. To successfully execute this task, a number of elements are crucial for avoiding operational pitfalls. Some of the risks and the keys to mitigating them resolve around:

- Internal barriers to innovation – these can stem from inflexible processes and systems that can lengthen time-to-market and contribute to high production costs for new services. They also include organizational issues. However, as operators move away from service stovepipes by incorporating innovative service delivery capabilities, they can find ways out of this potential trap;
- Misunderstanding end-user needs and their evolution – intimate knowledge of the subscriber base is critical to providing the proper service mix and experience, and therefore to avoid user dissatisfaction and churn. However, by employing the right techniques and tools to identify and follow end-user preferences and changing behaviours, service providers can develop compelling offers and generate additional revenue.

Improperly managed risk can result in lost opportunities, spoiled investments, offended shareholders and lost customers. Apart from the services themselves, offering the right user experience is a cornerstone for success in today's environment. From a business perspective, it is critical to have the lowest possible cost structure because the new competitive reality involves players with nimbler infrastructures and simpler operational systems.

Service providers must be able to launch new services flexibly, while reducing the significant costs associated with service creation, deployment, operation and billing. This same flexibility and cost efficiency must also be brought to bear when retiring unsuccessful services. Service providers will need to experiment with different mixes of telephony, web, video and other offers. New market conditions also put pressure on service providers to find non-traditional revenue sources by implementing creative and innovative new business models.

In order to do so, service providers must break down barriers between internal service silos in order to provide a single, rich, end-user experience. The ability to readily and seamlessly access the assets within each silo becomes critical in responding to end user behavioral trends. An Alcatel-Lucent research conducted in 2007 shows that end users are, in fact, more willing to pay services that seamlessly blend content and multiple capabilities rather than for more connectivity, such as the ability to access all services and content via any device, using a single network-based address book (Pastuszka, 2008).

The key to successfully creating user-centric services lies in effective collaboration among internal service provider departments, as well as with content providers and other service partners. For instance, since service expectations are no longer bound to dedicated infrastructures, it is important to create and manage services independently. It is important to break down infrastructure silos in order to effectively blend legacy telephony, Web, IMS, IPTV, TV and mobile services.

At the same time, to embrace new opportunities, service providers must intimately understand the end user so they can offer services that deliver compelling end-user experiences. More than defining the proper service mix, end-user intelligence opens up new ways to generate revenue. For instance, in the United States, operator Virgin Mobile is offering free minutes to users in exchange for the opportunity to show them targeted advertisements. Instead of paying money, end users are offering personal information in exchange for services. Virgin is then using its subscriber reach to generate revenues from brand managers and marketers (Pastuszka, 2008).

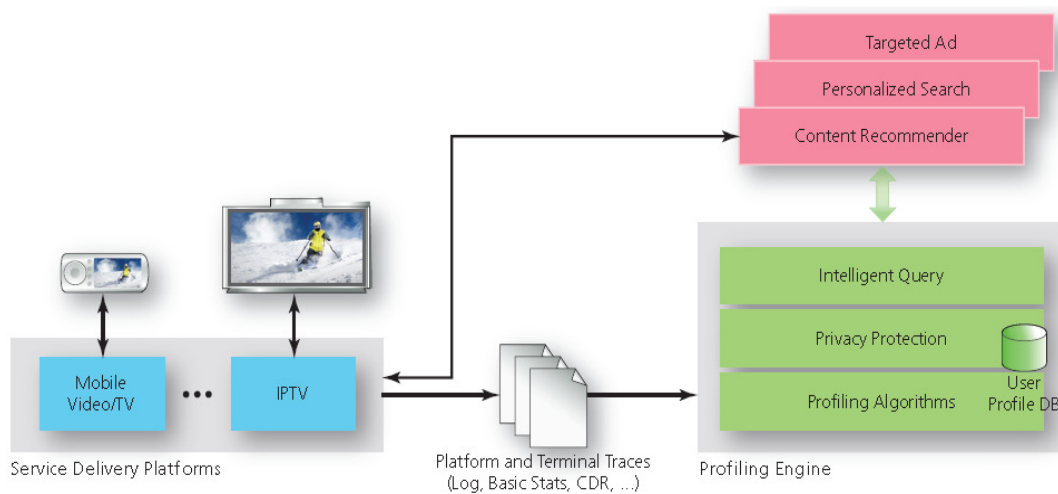
To effectively monetize their subscriber relationships, it is crucial for service providers to do more than simply provide advertisers with access to users. Service providers must first organize their data with a subscriber data management (SDM) solution to ensure consolidation at the network and service layers and perfect their understanding of user preferences and behavior patterns or profiles.

New user profiling techniques take this analysis to the next level. They capture knowledge about the end user on a much more frequent basis. Service providers can leverage their existing one-to-one relationships with customers by using profiling techniques to analyze and interpret day-to-day user behavior and data. In this process, providers come to know their customers not just as segments or demographic groups, but also as unique individuals.

Service providers already have data on end-user service consumption trends and are well positioned to accurately infer user preferences, interest domains and behavior patterns. To leverage this information and deliver value-added services, service providers need to employ an efficient profiling tool.

One interested research prototype developed by Alcatel-Lucent Bell Labs enables service providers to accurately and automatically learn about end-user preferences and understand customer behaviors in real time.

Figure 78: Profiling engine developed by Alcatel-Lucent Bell Labs



Source: Pastuszka, 2008

With the profiling engine (figure 78), operators will dynamically learn and update the user

profile in a rich multimedia service environment. It accurately represents the real-life evolution of the user's interests and behavior. The profiling approach is fundamentally different from efforts currently based on web and e-commerce technologies. For example, solutions like *Google AdWords*, *AdSense* and *Amazon Recommender* are dedicated to a particular web-based, personalized application. With the Alcatel-Lucent's profiling engine, service providers can differentiate from web and IT actors by conducting profile analysis of multiple personalized applications. It accomplishes this by leveraging diverse usage data collected from different SDPs, such as mobile video/TV, mobile portals, IPTV, IMS and others.

4. How could Network Operator extend its services to be available in a MANET network?

Nowadays, user communication requirements are much more than simple connectivity. It is required to assure full service connectivity with high quality, independently of the user's location, and providing the best access at every time. The concept of mobile ad hoc networks (MANET), which include spontaneous grouping of nodes using wireless technologies and collaborating in order to provide communication facilities, gives an alternative path to these full connectivity requirements.

A MANET network, which is informally called as a network without infrastructure, only contains mobile nodes and it has no fixed station or wire connection, which is applied to data transaction and network management. Each mobile node doesn't just act as a host, but it acts like a router. The nodes are themselves responsible for packet forwarding to other present mobile nodes in the network. Since network creation infrastructure causes limitation in normal cell and mobile networks, so non-infrastructure networks can be a good idea for the wireless communications continuation.

Network operators can offer their IP based real-time communication services following two very different approaches. In the first case, the service meant to replace traditional telephony: the main focus is on requirements, such as quality of service, high availability and standard supplementary services, in line with the evolution of NGN, such as the IMS technology introduced in this scenario, which is highly centralized, layered and oriented to a powerful and sophisticated service session control, and thus to a stronger user profile management. On the other hand, much younger companies committed to the provision of services on the Internet, have started adding audio and video to their user's experience, once limited to web browsing and file-sharing, exploiting the abundance of bandwidth today available at low cost. In this case, real-time communications, one of many kinds of complementary services, need in the first place to be as cheap as possible on the detriment of quality.

The ongoing IETF P2PSIP standardization effort represents a step in a common direction by two worlds, which are often considered parallel and controversial, but which can profit by their co-existence and co-operation, extending their range in each other's domain.

According to Bryan (2007), the P2PSIP approach would minimize capital expenses by eliminating SIP servers and reduce operational expenses related to keeping those servers running. P2PSIP will be ideal for ad-hoc and small-scale systems whereas large deployments

would be based on the client-server model due to reasons related to control, charging, legislation and regulation. P2PSIP replaces the fixed hierarchy of the client-server SIP with a P2P overlay network. The main task of this overlay is to provide a distributed mechanism for mapping names to network locations, thus replacing the location server function of the original SIP standard. Another task of the overlay is to provide a transport function for transporting SIP messages between any two nodes in the overlay.

In table 16 we show the main differences between services provided in IMS networks and in P2PSIP overlays.

Table 16: Comparison between services provided in IMS networks and P2PSIP overlays

	IMS	P2PSIP
Payment	Subscription based	Free / Advertising based
Quality	Guaranteed	Best effort
Interconnection with legacy networks	Transparently supported	None / Externally provided
Target	Home, Business	Web / Virtual Communities

Source: Marocco et al., 2007

Based on table 16, we can see that the most significant competitive advantage of mobile peer-to-peer communications is the cost savings for users. Flat rate mobile data pricing enables users to make calls without additional cost within the P2P communications network. From the viewpoint of the network operator, the increased P2P traffic can impose challenges, as has been evident in fixed networks (Hablinger, 2005). Furthermore, mobile networks are limited on more technical aspects than data networks, such as the wireless link capacity. The operator has to establish a balance between increased revenue from mobile data usage, increased cost from network investments and revenue losses from decreased circuit-switched voice usage.

There are also some important limitations in the adoption of a P2PSIP approach. Firstly, the extent of the operator control of their networks is an important determinant for the success of mobile P2P communications services. At the moment, some European network operators disallow the use of mobile P2P applications in their terms of service and others prohibit the excessive use of mobile P2P applications. At the same time, possible usability issues of mobile P2P communications services may limit their adoption (Heikkinen, 2008).

7.4.5 Main conclusions of each scenario

7.4.5.1 Scenario I

In the first scenario the Network Operator introduces a Unified Communications solution in the market. The concept of Unified Communications (UC) is recent but can be considered a successful approach, especially when addressed to the SMB market. UC have the potential to dramatically simplify and improve enterprise communications, reducing costs and improving revenue opportunities. The proposed architecture for a UC solution based on Open Source technologies and open standards will provide enterprises with a UC platform with lower costs

of ownership, faster time to deploy new solutions and greater flexibility. At the same time, it will also enable greater mobility and functionality for end-users. However, typically, Open Source providers need to gain credibility before they can be taken seriously by the market. Signing with valuable partners and winning important awards can help greatly, like it was demonstrated by edgeBOX provided by Critical Links.

The Network Operator can follow two different levels of involvement with the software development process, respectively: lighter involvement and deeper involvement. In a lighter involvement strategy, the Network Operator would spend few resources in the community; in a deeper involvement strategy, the Network Operator would spend more resources in the community, such as participating in the production of the source code, testing various pieces of software in various environments, tracking and fixing problems reported by the user community.

There are other two entities that deploy important roles in this scenario: the Open Source Support Service Provider and the Quality Certification Entity. The Open Source Support Service Provider will be responsible for the monitoring of IT networking and detection of the origins of failures, due to maintenance procedures, power outages and congestion or malicious attacks. As an example, this entity could perfectly offer an integrated fault-injection tool to evaluate the detection efficiency in terms of both failure detection coverage and latency by fault-injection experiments. The Quality Certification Entity could help the Open Source System Integrator to guarantee a high level of interoperability between the several different OS components that composes the UC solution. The Quality Certification Entity would assure that OS solutions will continue to work together over update cycles before it has been widely integrated and used by companies that adopted the UC solution.

The idea to build a Unified Communications solution based exclusively in Open Source software and open standards takes advantage of the large amount of OS applications available in the market in the fields of networking, storage, VoIP, security and multimedia. Besides that, the use of Open Source standards offers a greater interoperability, empowers consumers by transforming them into co-creators, eliminates patent fees resulting in a reduction of total costs of ownership (TCO), and enables the citizens and experts in general to inspect the source code and expose its vulnerabilities. It is important to notice that the use of an Open Source and open standard architecture will give the power to the users to extend this application according to their needs. For example, Dr. Raúl Oliveira from iPortalMais mentioned a case where a company extended the IPBrick.GT solution to a night video-system vigilance. At the same time, Open Source provides a levelling framework for collaboration between economically emergent countries and the in-developed world; also, the actual scenario of economic crisis may serve to accelerate the adoption of Open Source software: as the pressure increases to reduce operating costs, senior management will be receptive to initiatives that promote the use of OS software.

The use of Open Source software and open standards by the Network Operator will drive the companies to an important role in the open innovation paradigm. Open source makes collaboration easier but it is still difficult to manage. Joint projects can only work with common objectives, trust and an established business model that makes sense for each part.

The open innovation paradigm is mostly more important among SMEs, because small firms often lack resources to develop and commercialize new products in-house and, as result, they should be more inclined to collaborate with other entities, such as large firms, universities and R&D centres. Besides that, the formulated framework is attractive for the participation of universities and R&D centres, where they can act as an Open Source Consultant.

However, the scenario I comprises some issues that shall be considered. Among them, we shall give a special attention to the way that customers perceive the UC value proposition and to the partners that could help Network Operator to complement its value proposition in international markets.

The value proposition offered by Network Operator shall always seek to satisfy the customer's needs. Attending to the case studies analyzed in this research work, we learned that the top five crucial requirements for success are: simplified deployment and management, higher productivity and convenience, significant cost savings (Capex and Opex), Service Level Agreements (SLA) and technical expertise.

When the Network Operator wishes to address the international market, it should consider the use of distributors or resellers. The distributors shall only be used when there is a large potential market of end-users and the Network Operator does not want to support numerous resellers individually. Typically, a better approach is to consider the use of resellers or value-added resellers. Resellers expect to market directly the UC solution, while value-added resellers will include the UC solution or parts of this solution in an overall product that they are selling to their clients. For example, value-added reseller could introduce in the international market a UC platform fully integrated with applications, such as Customer Relationship Management (CRM), Enterprise Resource Management (ERP), Supply Chain Management (SCM) and Content Management Systems (CMS). In all circumstances, the reseller training (sales and technical) should be mandatory to improve the communication channels between Network Operator and resellers, and to guarantee that the reseller will have the product and marketing knowledge that will be needed to successfully sell and support the product. Another possibility is to use a Web channel. This is especially suitable for start-up companies that are addressing a new international market without making big investments in logistic and marketing. However, the company should always consider eventual shipping and value-added taxes costs. Besides that, it is crucial to consider a secure payment method.

7.4.5.2 Scenario II

In the second scenario the Network Operator introduces a VoIP service to provide its customers with a VoIP solution taking into account required features, such as voicemail, call forwarding, call blocking and guarantee of a certain QoS. Besides that, the offered solution should be vendor independent, highly reliable and developed with minimal costs. Attending to these specifications, the available proprietary VoIP products are not the best choices, since these products are not vendor independent, have expensive license prices and deny the possibility of assessing the quality and security of the source code. Therefore, the best option is to use an Open Source product. In the market, there are some available solutions: among

them, we suggest the Asterisk that is a complete PBX solution and one of the most promising software in the field of IP-base telephony.

Typically in this scenario we can consider that two entities will deploy an important and distinct role attending to the generic framework presented in this research work. The Training Providers can offer two types of VoIP training courses: platform and non-platform specific. The platform VoIP training courses are basically certification courses offered by professional training teams that are experts in OS VoIP platforms like Asterisk or sipX; the non-platform specific training courses may not result in a certificate for the trainee, but will have all ingredients to educate the trainee on the details of VoIP technology and issues related to its implementation. Very hardly, the Training Provider will have conditions to give only formation and training session in OS solutions. A more realistic approach will be the simultaneously inclusion of formation courses in proprietary and Open Source solutions, which was confirmed by Luís Morgado from Rumos. The Quality Certification Entity should provide an IT certification that addresses the two most important issues in a IP-based communication: Quality of Service (QoS) and security.

The scenario II also comprises some issues that shall be addressed. Among them, we shall give a special attention to the customers' channels that a Network Operator shall use and establish a methodology for the Network Operator to spend less time and resources on unprofitable clients.

The distribution channels for VoIP solutions were evaluated in this research work, enabling us to reach to the following conclusions: direct channel is appropriate for VoIP solutions that contain a lot of technical specificities that conduces to a difficult customization and the market size is small; the wholesaler channel and broker channel should be used when the VoIP provider offers an easily customized solution, the addressable market size is large and when they have strong relationships with large local retailers of different geographic markets; the retailer channel is suitable when the Network Operator wants to keep a strong relationship with a local partner, and when the use of this local partner is a competitive advantage for the VoIP provider.

The initiative to segment VoIP customers attending to profitability is very important in IP-based communications. In VoIP communications, typical prices of communications are relatively low and it isn't easy to create a loyalty program to meet the specific requirements of the customer market. Our suggested approach is to establish segmentation based on the following four classifications: profitable, sustaining, entry and unprofitable. Using CRM software and analytical tools, it is possible to complement demographics and customer preferences segmentation with an assessment of customer long-term profitability.

7.4.5.3 Scenario III

In the third scenario the Network Operator wants to provide a converged fixed-mobile solution to its customers composed of a wide range of applications, such as instant messaging, IP Centrex, Video on Demand (VoD), presence, personal information

management (PIM), gaming and location based services (LBS). The idea of offering all these services together is possible using a IMS architecture, which is the best suited form for blending real-time and non real-time multimedia services. Besides that, IMS supports the concept of an Open Source creation model that allows the inclusion of third-party applications and application servers, enabling operators to tailor services and applications for their customers. In fact, the potentiality of the IMS architecture allied with the flexibility of our framework turned easier the creation and delivery of Open Source based services.

The 3rd Party Service Provider can exist separately or can join the Open Source System Integrator to provide value-added services based on OS solutions. Therefore, the 3rd Party Service Provider can act as a small integrator of OS solutions in specific domains of the overall IMS architecture, such as mobile entertainment and location based services. In this scenario, the customer would pay for the data transport and for 3rd Party Service Providers.

The introduction of the IMS architecture for this scenario will decrease the time-to-market of these solutions because application developers are no longer hampered by multiple integration and deployment efforts; it will reduce significantly the complexity of the systems, decreasing CAPEX and OPEX especially in a complex service environment, and will allow the Network Operator to increase its value chain control. Besides that, universities and R&D centres with advanced knowledge in the fields of networking and telecommunications can participate as a 3rd Party Service Provider or as an Open Source Consultant Entity, and the actual scenario facilitates the participation of technological-based start-up companies as a 3rd Party Service Provider encouraging also the appearance of start-up companies as spin-offs of R&D centres and universities. On the other hand, the introduction of the IMS architecture will bring additional difficulties to measure the customer's quality of experience (QoE).

The scenario III also comprises some issues that shall be considered. In a first level, it is important to evaluate the degree of partnership between the Network Operator and the 3rd Party Service Provider. Secondly, it would be interesting to consider the introduction of new revenue streams from the Web 2.0 and Mobile Web 2.0 concepts to an IMS-based approach.

The best way to evaluate the partnership with 3rd Party Service Providers is to look to the level of integration between these services in the IMS architecture. We can analyze it, looking to the level of convergence of the overall solution provided by the Network Operator. The level of convergence should be analyzed attending to the following six approaches: convergence of devices, convergence of telecommunications networks, convergence of media and content, convergence of services and applications, convergence of tariffs and pricing models, and convergence of industries.

The combination of IMS and Web 2.0 may introduce operators to new business models, which can stand alone or be used in various combinations. Each of these business models reduces operational costs or increases the top-line revenue. The business models that result in cost savings are outsourcing, wholesaling, asset-sharing and hosted services, while content aggregation and brokering, advertising and user-generated content increase the top-line revenue.

8 Conclusions

Creation of value with Open Source software is a big challenge, but also a great opportunity for any telecommunications company. The emergence of Open Source software has fundamentally changed the software business. The simple facts that production is carried out mainly by voluntary private programmers and that the marketable outcomes are supplied to consumers for free have resulted in far-reaching effects on market structures, business models and innovation processes in the software industry. While incumbents have to change their strategies to take into account this newly emerging competition, OSS-based firms have to develop viable business models enabling them to generate profits. These fundamental changes in the software industry have subsequently attracted the interest of analysts, business people and researchers.

8.1 Summary and Main Conclusions

In a first phase of the research project, we analyzed the today's telecommunications industry, where the mobile communications have gained an increased importance compared to fixed-lines communications, and have overtaken it in 2002 on a global scale. Besides that, the VoIP technology is disrupting the actual voice and data markets promising lower costs and greater functionality and flexibility, compared with conventional fixed lines, and has the potential to become the future of voice telephony. This situation will bring great opportunities for many players in the market, but, at the same time, it will have a negative impact in their revenues. In the long term, players will have to look for new innovative and targeted tariffing strategies in an attempt to preserve already thin profit margins.

Consecutively, we reviewed the main business models adopted by telecommunications companies. Presently, all the classical business models have been adapted to the new technology changes and customer demands, originating new current value chains, such as the Internet value chain, mobile value chain, broadcast value chain and hot-spot industry value chain. However, these actual and most cited value chains in literature are already under pressure and they should be reconfigured to take into account the evolution of the telecom market, namely considering that consumer world is dominated by intangibles, not driven by technology. Besides that, the consumer market requires simultaneous personalization and mass market stimulation; as a result, new emerging value chains, such as IMS, mobile broadcast convergence and ambient networks are appearing on the market.

The study proceeded with the analysis of the innovation process in the telecommunications field, which is characterized mainly by radical innovations. An empirical evidence suggests the existence of a systematic relationship between technology-based R&D and the emergence of radical innovations. During the past 20 years, the voice telephony market assisted to the appearance of IP-telephony, which provided a reliable and cheaper way to translate voice traffic into data packets and route them over existing IP networks, which conduced to the convergence between voice and data networks. In this context, the Open Source software gains an increased importance in a lot of economic domains. The Open Source software can

be characterized as a movement, where communities of highly skilled developers collaborate deeply to create software, often with a quality that outperforms commercial proprietary software. The Open Source movement has also been said to provide important management lessons regarding the most effective ways to structure and implement innovation. The lessons of Open Source demonstrate the value of specialization through self-selection and how norms of meritocracy and peer recognition help ensure product quality. Attributes, such as quality, security, flexibility, reliability, time and cost savings, are benefits being generated by the Open Source development model.

The concept of Open Source can also be part of the implementation of an open innovation strategy. This is still a recent phenomenon, but has already the potential to fill the gap between innovation and product, and represents a great way for companies to create value in their target market. The concept of open innovation is becoming increasingly popular, particularly in SMEs, because small firms often lack resources to develop and commercialize new products in-house and, as result, they are more often inclined to collaborate with other entities, such as large firms, universities and R&D centres.

Subsequently, the dissertation presented the most important new emergent technologies in the telecommunications field. The IPv6 increases the scalability of IP networks and introduces new features, such as security, automatic configuration and advanced classes of traffic. The IMS provides a framework for network operators to build and launch access-agnostic services, allowing new applications, whether developed in-house or outsourced to third-party developers, to be quickly integrated into IMS due to the nature of the architecture. The VoIP implements an easy and cheap way of sending voice information in data packets over IP networks. MANET is a network architecture that can be easily deployed without a pre-existing network infrastructure, where its nodes can dynamically join and leave the network.

The study proceeded with the presentation of seven case studies of companies that use Open Source software solutions in the development of their products. The selected companies were categorized in four groups according to the scope of their solutions and commercialization strategy. The case studies helped us in the definition of an extended Open Source business roles model initially proposed by Eurescom to create value with Open Source software in the telecommunications industry. The case studies also contributed to learn how the commercial success of companies can be achieved using Open Source software, they gave us important elements to analyze the core competences and strategy followed by each company and information about the importance of a partnership with others private companies and universities/research centers.

Motivated by the appearance of new technologies in the telecommunications market and the need for companies to know their adequate positioning in the telecommunications value chain, we proposed an extended Open Source business role model initially proposed by Eurescom, which encompasses ten roles and certain relationships between these protagonists. This model can be seen as a meta-business model, which enables the definition of a specific business model suitable for a particular business scenario. On the other hand, the model initially proposed by Eurescom is exclusively addressed for Public Network Operators

(PNOs), which is not suitable and flexible enough to be used by start-up or spin-off companies. Therefore, we chose to extend this model to cover all the telecom value chain, which led to the appearance of new concerns in terms of the value proposition that should be offered to end-users, the considered distribution channels and customer relationship approach, and the most proper strategy to penetrate international markets.

These business roles previously presented were instantiated for three different scenarios: Unified Communications Solution, VoIP Service and IMS-based Services. The process of analyzing the correct application of the Open Source business role model to each scenario was done using the Osterwalder business model conceptualization.

In the first scenario, the Network Operator introduces a Unified Communications in the market. The use of a UC application simplifies communications and allows employees to communicate with each other in an integrated way using only a single device. UC solutions integrate collaboration and communication technology, linking together collaboration technologies, such as email, instant messaging and calendaring, with communication devices, such as telephones, voice messaging and video. We suggested the idea of building a UC solution based exclusively in Open Source software and open standards, which would offer a greater interoperability and reduce the total costs of ownership (TCO).

In the second scenario, the Network Operator introduces a VoIP service. We chose to use an Open Source product, more specifically the “Asterisk” that is one of the most promising software in the field of IP-based telephony. The VoIP solution implements the most common features of any proprietary IP-based solution and must also implement a prioritizing function for voice traffic and guarantee a certain QoS. Besides that, the considered VoIP solution shall be vendor independent, developed with minimal cost and the security of the system shall be accessed. The VoIP solution shall support PC-to-PC, Phone-to-Phone over IP, or PC-to-Phone/Phone-to-PC communication scenarios according to the involved terminal equipments and types of network.

In the third scenario, the Network Operator introduces a converged fixed-mobile solution composed of a wide range of applications, such as instant messaging, IP Centrex, video on demand, gaming and location based services. All these services could be provided using the IMS architecture, which supports the concept of an Open Source creation model that allows the inclusion of third-party applications and application servers. The introduction of IMS in this scenario will decrease the time-to-market of these solutions, will reduce significantly the complexity of systems decreasing CAPEX and OPEX, especially in a complex service environment, and will allow the Network Operator to increase its value chain control.

8.2 Recommendations for Future Work

There are numerous opportunities for research on the entire value chain of the proposed Open Source business model roles. Besides that, for each considered scenario we can study in more detail some open issues that were lightly mentioned in this dissertation.

In a first instance, we could analyze in more detail the quality concerns of Open Source software as driven by industrial adoption. It would be interesting to review the major quality evaluation models and analyze the challenges of Open Source quality assurance of certification. In fact, for many software companies, adopting Open Source software is still considered a risky business, mainly due to the lack of trust in community-driven software. The main concern is that many quality attributes, such as reliability, security and safety are hidden properties that have to be carefully checked, and that fixing software defects pertaining to such quality attributes can never be guaranteed. In order to alleviate such concerns, it would be important to introduce a quality evaluation framework for Open Source software that would introduce Open Source certification programs. The QualiPSo European project is already addressing this issue and could be interesting to use some of the outputs of this project to validate and detail the role of the Quality Certification Entity.

Other interesting point to be analyzed is the establishment of a metric to evaluate the impact of Unified Communications in a corporate environment. It would be useful for many companies to have a more concrete idea about the economic benefits of the introduction of a UC solution in terms of capital and operational expenditures (Capex and Opex). Besides that, it would be interesting to have a metric about the increased workplace productivity provided by UC solutions.

During this research project, we studied several VoIP companies that intend to introduce VoIP communications in a business environment. We slightly referred that the majority of those companies do not address the residential market. However, the residential market of VoIP communications is huge and it is expecting to grow at a level of 110% per year, only in USA (www.voipmonitor.net, 2009). Therefore, there is a big addressable market, which has specific requirements. It would be important to give a specific value proposition for this market, taking into account a price discrimination strategy and the introduction of value-added services that residential users would enjoy and are willing to pay for.

The Network Operator shall also always be concerned about the Quality of Experience (QoE) of its solutions, which reflects the level of satisfaction of the end-user. The Network Operator needs to be able to measure the user experience in a consistent manner that must be in accordance with the application's business value. An approach to implement this study would be to deploy a next generation Application Performance Monitoring (APM) tool in order to take measurements, and then compare its output with a well understood industry-wide performance reporting metric.

The IMS architecture that we suggested in scenario III presents significant security challenges that must be addressed by operators as IMS moves to widespread deployment. The generally open and distributed architectures create the advantage of flexibility in implementation and deployment, but also create a multitude of interface points that must be secured. Security around the IMS is already a significant part of the 3GPP standard work. In particular, the 3GPP is very concerned with the significative delay of the introduction of IMS architecture by Network Operators and recently divulged a package of recommendations to propose solutions for early deployments of the IMS. Among them, the 3GPP proposed a methodology to deliver IMS services using a IPv4 infrastructure and a way to support IPsec

in mobile handsets that do not support it. However, there are some areas that were not addressed by the 3GPP group, namely QoS guarantees in a IMS architecture, an Open Source architecture for charging and billing of IMS services and the impact on performance of an IMS architecture with the introduction of several security appliances, such as SIP-aware firewalls, Session Border Controllers (SBC) and other application specific gateways that are all part of proposed security solutions.

Finally, we must recognize that the IMS is being deployed in a complex world of regulatory constraints. As an international standard, the IMS will be deployed in environments with distinct, perhaps conflicting, policy requirements. Issues such as emergency service contact requirements, number portability, and widely varying personal privacy obligations mandate specific service availability and data access requirements. All of these issues would benefit from further study.

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<http://www.emergic.org> – Rajesh Jain's Weblog on Emerging Technologies, Enterprises and Markets

<http://www.gnu.org> – The GNU operating system

<http://www.gnu.org/copyleft/gpl.html> - GPL full license description

<http://www.redhat.com> – The Red Hat Company

<http://www.conecta.it> – European working group on libre software

<http://www.sgi.com> – Silicon Graphics Inc.

<http://www.hp.com> – The Hewlett-Packard Company

<http://www.nmscommunications.com> – Natural Microsystems Inc.

<http://www.collab.net> – CollabNet Inc.

<http://www.omg.org> – The object management group

<http://www.apache.org> – The Apache Software Foundation

<http://home.netscape.com/company/index.html> - The Netscape Company

<http://www.ericsson.com> – The Ericsson Company

<http://www.oreilly.com> – O'Reilly Media Inc.

<http://www.vovida.org> - Forum for Open Source Software used in datacom and telecom environments

<http://www.fsf.org> – The Free Software Foundation

<http://www.opensource.org> – The Open Source Initiative

<http://sourceforge.net> – Open Source applications and repository

<http://www.openclovis.com> – OpenClovis Inc.

<http://nosoftwarepatents.com> – Association to promote the freedom of software.

<http://www.tmforum.org> – TeleManagement Forum

<http://www.ambient-networks.org> – Ambient Networks Initiative

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<http://www.biocomsystems.com> – Bicom Systems company website

<http://www.edgebox.com> – Critical Links company website and edgeBOX product

<http://www.iportalmais.pt> – iPortalMais company website

<http://www.ipbrick.com> – IPBrick solutions developed by iPortalMais company

<http://www.voipmonitor.net>

<https://fossbazaar.org/?q=resources/legalServices> - List of companies that provide legal services in Open Source solutions.

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Annex A – International Organizations with a Major Role in Telecommunications Regulation

Organization	Activities
African Telecommunications Union (ATU)	ATU co-ordinates the development of African telecommunications networks. It promotes telecommunications development in Africa by serving as a regional discussion forum.
Caribbean Telecommunication Union (CTU)	CTU promotes telecommunications development and regulatory reform by serving as a regional discussion forum. It also promotes co-ordination of the international policies of its 13 English-speaking Caribbean member states.
Common Market for Eastern and Southern Africa (COMESA)	COMESA serves the English-speaking sub-regions of Eastern and Southern Africa. In collaboration with the ITU, COMESA's Transport and Communications Division provides technical assistance in several areas, including network connectivity and tariffs.
European Bank for Reconstruction and Development (EBRD)	The EBRD is an international financial institution established along somewhat similar lines as the World Bank Group. The EBRD supports telecommunications privatization in Central and Eastern Europe and in the former Soviet Union (FSU) through the provision of equity or long-term debt financing to newly privatized companies and by providing pre-privatization finance. The EBRD provides support for new network operators in local, domestic and international long distance, and mobile telephone services. It also supports regulatory reforms through its Technical Co-operation Programme, which has provided assistance to national authorities in establishing and improving the telecommunications legal and regulatory framework.
European Conference of Post and Telecommunications (CEPT)	CEPT's Telecommunications Committee (ECTRA) promotes co-operation between member administrations and bodies responsible for telecommunications policy and regulation. Its activities include harmonization of licensing conditions, spectrum management and numbering.
European Commission – DGIS	The EU shapes telecommunication law and policy in Europe through legally binding instruments. Its directives on different aspects of telecommunications liberalization aim at developing a common market for telecommunications service and equipment throughout Europe. The Directorate-General for the Information Society (DGIS) implements the European Commission's policies in the area and elaborates the economic, political and social analyzes on which such policies are based. The DGIS supports telecommunications sector reform through programs and initiatives, which include monitoring activities and assistance in the establishment of regulatory framework consistent with the Commission's policies. The European Union provides additional support for economic reform in Central and Eastern Europe through development programs such as PHARE and TACIS.
European Telecommunications Office (ETO)	ETO supports the establishment of new regulatory regimes for liberalized telecommunication markets and promotes the harmonization of existing regulations. It promotes the establishment of common procedures for licensing and numbering. ETO also provides a forum for discussion and analysis of national situations and undertakes studies on issues of topical concern. Recent ETO studies cover the areas of licensing, pricing, numbering and mobile number portability.
Gulf Co-operation Council (GCC)	The Telecommunications Department of the GCC has assisted Persian Gulf member states to co-ordinate telecommunications service tariffs, adopt the GSM mobile telephony standard and harmonize the curriculum taught at academic institutions and training centres in GCC member states. It also works with the ITU to promote harmonization and standardization processes.

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Inter-American Telecommunications Commission (CITEL)	As the principal advisory body to the Organization of American States (OAS) on matters related to the telecommunications, CITEL's main objectives are to facilitate and promote the development of telecommunications in the Americas, in order to contribute to the overall development of the region.
International Institute of Communications (IIC)	The IIC is a multidisciplinary organization that brings together policy makers, regulators, academics and industry players. It provides a forum for exchange of ideas on topics related to telecommunications and their commercial, cultural, political and social implications. It maintains an active publication program, hosts an annual conference and organizes international forum on a regular basis.
International Telecommunication Union (ITU)	The ITU is a global organization which includes public and private sector participation in telecommunications market. The ITU mission covers technical, development and policy domains.
Latin American Forum of Telecommunications Regulators (REGULATEL)	REGULATEL encourages co-operation of efforts among 16 Latin American telecommunications regulatory agencies and promotes the development of telecommunications in the region. It provides a forum for discussion and for the exchange of information and experience in telecommunications policy and regulation.
Mercosur (Southern Common Market)	Mercosur supports telecommunications liberalization among its members (Argentina, Brazil, Paraguay and Uruguay). Through its Public Telecommunications Services Commission, Mercosur promotes regional telecommunications development, harmonization of spectrum management and equipment certification and homologation as well as the exchange of information on telecommunications topics.
Organization for Economic Co-operation and Development (OECD)	The OECD publishes data and studies on telecommunications markets. It promotes the telecommunications reform as a means to achieve sustainable growth and employment that contributes to economic and social welfare, as well as to the expansion of world trade.
Pacific Telecommunications Council (PTC)	PTC membership includes individuals, businesses and non-profit entities. It provides a forum for discussion and exchange of information on telecommunications in the Pacific area. It promotes regulatory reform and general awareness of the telecommunications sector in the area. PTC organizes conferences and seminars and interacts with national, regional and international organizations responsible for telecommunications policy and regulation.
Regional African Satellite Communications Organizations (RASCOM)	Among RASCOM's main objectives is the improvement of inter-urban communications in its member states through the establishment of direct satellite links between African countries. It also promotes the provision of telecommunications service to rural and remote areas.
Regional Commonwealth in the Field of Communications (RCC)	RCC co-ordinates network development, technical standards and spectrum management activities in CIS countries. It also co-operates with its members in the development of principles governing tariff policy as well as network interconnection and interoperability. In addition, the RCC is involved in joint research and development programs, and the training of communications specialists.
Telecommunication Regulators Association of Southern Africa (TRASA)	TRASA's main goal is to increase communications and co-ordination between regulatory authorities in the Southern Africa region. TRASA seeks to encourage investment in the telecommunications sector by supporting the creation of a common enabling environment. The member states of the Southern African Development Community (SADC) are committed to undertaking initiatives to improve the economic and social well-being of their populations through telecommunications sector reforms.
West African Telecommunications Regulators Association (WATRA)	WATRA was formed in September 2000 by West African telecommunications regulators, as a regional organization similar to TRASA

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World Trade Organization (WTO)	The WTO is the international body responsible for the administration of the General Agreement on Trade in Services (GATS), which includes an Annex on Telecommunications and a Protocol regarding basic telecommunications services. The WTO provides a global forum for trade policies and provides technical assistance and training for developing countries concerning the implementation of their WTO commitments, including required regulatory reforms.

Source: Gustafson and Koff, 2004

Annex B – Open Source Software Licenses

1. Overview of major licenses in Open Source domain

	GNU General Public License (GPL)	Lesser General Public License (LGPL)	BSD License
Use of License	License can be used for any software; however, it may not be modified.	License can be used for any software; however, it is designed primarily for use with code libraries. The license may not be modified.	License can be used for any software.
Fees	The licensee may charge a fee for the physical act of providing its customers with a copy, and may also charge a fee for any additional warranty protection offered.	The licensee may charge a fee for the physical act of providing its customers with a copy, and may also charge a fee for any additional warranty protection offered.	No express provisions.
Redistribution	Redistribution (including any modifications) must be on the terms of the GPL.	Redistribution (including any modifications) must be on the terms of the LGPL or the GPL.	Redistribution provided conditions in BSD license are met.
Availability of Source Code	Any redistribution must be accompanied by source code, or the licensee must offer to provide source code on request for a period of at least three years.	Any redistribution must be accompanied by source code, or the source code must be accessible from the same place as the object code.	No requirement to make source code available.
Application to Other Software	Any work that in whole or in part contains, or is derived from, the licensed software must be distributed under the GPL, but independent and separate works that are not derived from the program need not be so licensed. The mere bundling of separate software on the same distribution medium does not bring the separate software under the GPL.	A “work that uses the library” by being compiled or linked with it, and which contains no derivative of any portion of the library, falls outside the license. However, where software contains portions of the library as a result of such compilation or linking, that software may be distributed under any license terms provided that they permit modification for the customer’s own use and reverse engineering for such purposes.	No express provisions.
Warranties and Liability	No warranties and complete exclusion of liability to the extent permitted by law. The licensee can offer warranties to its own customers if it chooses to do so.	No warranties and complete exclusion of liability to the extent permitted by law. The licensee can offer a warranty to its own customers if it chooses to do so.	No warranties and complete exclusion of liability.
Governing Law	None	None	None

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Termination	License automatically terminates on breach by the licensee of its terms.	License automatically terminates on breach by the licensee of its terms.	No express termination provisions.

	Mozilla Public License (MPL)	IBM Public License / Common Public License	Apache License
Use of License	License may be modified and applied to other software provided it is renamed and otherwise makes clear that the new license contains different terms.	License can only be used for the licensed IBM software and contributions.	License can be used for any software. However, Apache Software Foundation projects must use this license and there is no dual license model.
Fees	The licensee may charge a fee for any additional warranty, support, indemnity or liability obligations offered.	No express provisions.	The licensee may offer a fee for warranty, support, indemnity or liability obligations to its customers.
Redistribution	Modifications must be licensed under the MPL. Covered code (original licensed software and any modifications) not released as source code can be distributed under different license terms, provided the license complies with the MPL.	If distributed in source code, must be under this license agreement. If distributed in object code, may be under a license of the licensee's choosing, although that license must then comply with certain conditions.	Redistribution must be on the terms of this license (including compliance with notice requirements, and the right to license modifications on different but consistent terms and conditions).
Availability of Source Code	All modifications must be made available in source code, either on the same media or separately available. For the latter, modifications must remain available for at least 12 months from becoming available or six months after a subsequent version has been made available.	Any object code redistribution must be accompanied by the source code.	No requirement to make source code available.
Application to Other Software	The licensee may combine the software with other programs, in which case these other programs are not affected by the MPL. However, the licensee must still comply with the MPL for all covered code (original licensed software and any modifications).	The license expressly states that it does not apply to: (a) separate software modules distributed with the licensed software under their own license terms, or (b) any software that is not a derivative work of the licensed software.	No express provisions.

Creation of Value with OS Software in the Telecommunications Field

Warranties and Liability	No warranty. Total exclusion of liability, except liability for death or personal injury resulting from a party's negligence to the extent applicable law prohibits such limitations.	No warranties and complete exclusion of liability. Where the licensee includes the software in a commercial product, the licensee must indemnify any other software contributors against certain third party claims.	No warranty and exclusion of liability for indirect or consequential damages to the extent permitted by law.
Governing Law	California	New York	None
Termination	License automatically terminates if breached and licensee fails to remedy within 30 days of becoming aware of the breach (all properly granted sublicenses survive). The license also provides for termination where the licensee brings a patent infringement claim against a contributor.	License automatically terminates if: (a) license is breached and the licensee fails to remedy within a reasonable period after becoming aware of the breach; or (b) the licensee institutes patent infringement proceedings against a contributor.	No express termination provisions. However, license automatically terminates if licensee institutes patent infringement proceedings against any entity.

Source: Lakhani, Wolf and Bates, 2002

2. Distribution of work and integration with proprietary software

	Proprietary Software linking [1]	Distribution of the work [2]	Redistributing of the code with changes [3]
GPL	Not allowed (since linked software is considered a whole).	Not allowed with software whose license is not GNU GPL compatible.	Only if the derivative is GNU GPL.
LGPL	Allowed (since the software that links to the library is not considered a derivative work).	Allowed with some restrictions. It must provide source code of the distributed LGPL library with (if any) modifications, changes to the LGPL library should be allowed to third parties and if BC your app/lib should still work with the modified LGPL lib/app.	Only if the derivative is GNU LGPL or GNU GPL.
BSD	Allowed.	Allowed.	Allowed
MPZL	Allowed.	Allowed.	Only under MPZL.
Apache	Allowed.	Allowed.	Allowed (as long as the name "Apache" isn't used in the name of the derivative work).

Source: Rusin, 2008

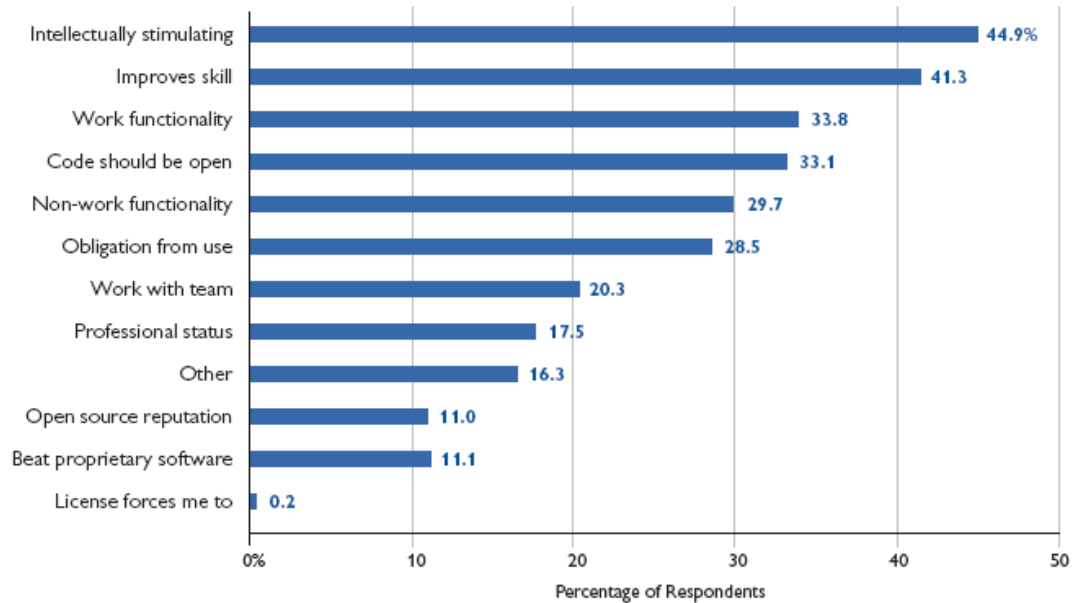
[1] The "Proprietary Software linking" refers to linking of closed sourced applications/libraries with applications/libraries licensed under one of the above Open Source licenses;

[2] By "the work" in the "Distribution of the work" means a combination of a software with the library or application licensed under one of the following licenses;

[3] "Redistributing of the code changes" refers to the act of redistributing a modified app/library based on the app/library licensed under the given license.

Annex C – Developers Motivation of Open Source Software

Developers motivation



Source: Lakhani, Wolf and Bates, 2002

Factors of motivation based on user's segments

Motivation	Believers	Skill Enhancers	Fun Seekers	Professionals
Code should be open	100,0%	0,0%	7,4%	0,9%
Improves skill	38,7%	100,0%	20,4%	4,7%
Non-work functionality	16,7%	24,2%	88,0%	0,9%
Work functionality	22,6%	24,2%	11,1%	70,8%
Intellectually stimulating	30,4%	46,9%	75,9%	34,9%
Professional status	9,5%	16,4%	3,7%	45,3%
Obligation from use	28,6%	25,8%	19,4%	38,7%
Status within OS community	7,7%	10,2%	6,5%	22,6%
Work with team	19,0%	28,6%	21,3%	13,2%
Beat proprietary software	13,1%	6,3%	13,0%	14,2%
License forces me to	0,0%	0,0%	0,0%	1,9%

Source: Lakhani, Wolf and Bates, 2002

Segments characterization (based on user's segments):

- Believers – do it because they believe that source code should be open;
- Skill Enhancers – do it for skill improvement;
- Fun Seekers – do it for non-work need and intellectual stimulation;
- Professionals – do it for work need and professional status.

Annex D – Arguments Against Copyleft and Proprietary Licenses Model

1. Arguments against copyleft

Open Source Initiative has accepted tens of different software licenses as open source. Based on license functionality, one can separate them into two broad categories: (1) permissive or academic licenses and (2) *copyleft* licenses, which include reciprocal obligations to share further development efforts at no charge.

The reciprocity obligation, also commonly called as the principle of copyleft, is stated for example in the section 2 b) of GPL as follows:

“2. You may modify your copy or copies of the Program or any portion of it, thus forming a work based on the Program, and copy and distribute such modifications or work ... provided that ... b) You must cause any work that you distribute or publish, that in whole or in part contains or is derived from the Program or any part thereof, to be licensed as a whole *at no charge* to all third parties under the terms of this License.” (www.gnu.org/copyleft/gpl.htm, 2007).

In other words, the license seems to require all joint development effort to be licensed reciprocally with zero royalties. As noted, one can argue that this constitutes an illegal price fixing or grant-back requirement for the benefit of the licensor. Further, one can argue that copyleft goes out of the scope of copyright in restricting licensee’s output and dictating the licensing terms for derivative product markets.

For example, Microsoft has advocated these arguments. In 2001, their CEO Steve Ballmer famously claimed:

“The way the license is written, if you use any open-source software, you have to make the rest of your software open source... [GPL’d software] is *a cancer* that attaches itself in an intellectual property sense to everything it touches” (Valimaki, 2005).

From the perspective of open source developers and their advocates, the justification for GPL 2 b) is simply that it is the very foundation of the open source development model. It encourages commitment to a common technology base or “brand” such as Linux and thus builds up an efficient development network. Further, even if the software product in question would hold a significant market share, it can be argued that the entry to derivative markets (application software etc.) is open to any software company since copyright alone does not reach to independent derivative products.

An established principle of competition law says that intellectual property licenses as such are held generally pro-competitive. As noted, however, critics have argued that copyleft extends the statutory foundations of software copyright law. The specific subject matter in question is the concept of derivative (as in US copyright law) or modified (as in EC directives) works.

The wording of GPL 2 b) as quoted above includes both “derived from” and “in whole or in part contains”. The first seems to be a direct link to copyright law but the latter might indeed

give an impression that GPL could cover much more than the derivative work concept in copyright law implies. One may argue that this latter part creates a vague contractual definition of what GPL means by a derivative work: another program needs only to contain parts of source code under GPL to become governed by it.

However, because there is no indication of the quantity or quality of the “contained” code and its relationship to the combined work, it could be further argued that the interpretation of derivative works applies also to the second part of the issue. It can hardly mean situations where non-copyrighted source code is used. In fact, the first term of GPL clarifies that:

“a work based on the Program” means either the Program or any derivative work *under copyright law*: that is to say, a work containing the Program or a portion of it, either verbatim or with modifications and/or translated into another language. Hereinafter, translation is included without limitation in the term ‘modification’ (www.gnu.org/copyleft/gpl.htm, 2007).

Further, open source supporters, and now, the software industry in general, argue that the scope of the copyleft clause has clear limits. In fact, most copyleft license authors provide detailed guides on how to avoid a situation where the license would pose problems to the licensing of a derivative or modified work. So far, there is no evidence that open source licensors would use these obligations with malicious intention trying to turn all software into open source.

2. Arguments against proprietary licenses

If a company in a dominant position refuses to license intellectual property, it can be interpreted, in certain exceptional circumstances, to constitute an abuse of the dominant position and thus a violation article 82 of the EC treaty. The criteria were developed in IMS Health decision, where a company holding the copyright to a *de facto* standard refused from licensing it to competitors. It was stated that a compulsory license can be issued if “it is determinative that two different stages of production may be identified and that they are interconnected, inasmuch as the upstream product is indispensable for the supply of the downstream product”.

From the perspective of software development, compatibility (or interoperability) standards can be interpreted as such “upstream products” subject to competition law analysis. Already in 1984 the EU Commission settled a competition law investigation against IBM after the company agreed to disclose its compatibility standards.

Recently, open source software developers have started to criticize industry-wide compatibility standards policies, which allow “reasonable and nondiscriminatory” (RAND) patent licenses. In essence, the critique is centered on the possibility to collect patent royalties from otherwise accessible standards. Since the copyleft clause does not allow the collection of even “reasonable” patent royalties, it may be impossible to implement a royalty licensed RAND standard in open source software. For example GPL clause 7 reads as follows:

“7. If, as a consequence [...] of patent infringement [...] conditions are imposed on you [...] that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Program at all. For example, if a patent license would not permit royalty-free redistribution of the Program by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Program.” (www.gnu.org/copyleft/gpl.htm, 2007).

In short, the open source licenses with copyleft clauses have a built-in termination mechanism that does not allow the development of software that requires royalty payments for the use of third party patents. In more technical wording, copyleft licenses are incompatible with patent royalties on software use: if there is a patent for some software invention and that patent is not licensed royalty-free to everyone forever, it is not possible to develop copyleft software for that invention.

One can thus argue that the copyleft clause can create an entry barrier for open source companies if dominating proprietary companies refuse to license their standards with compatible royalty-free terms. For example, during EU’s anti-competition remedy negotiations with Microsoft in 2005, Free Software Foundation Europe’s president Georg Greve critically argued against Microsoft’s royalty-based license proposal for the interoperability information they were required to disclose:

“The proposal specifically precludes the information from being used in a Free Software implementation, such as the Samba workgroup server software. As Samba is the only remaining major competitor of Microsoft in this market, the Microsoft proposal translates to: Of course we will give you the specifications, unless you happen to be a serious competitor of ours...” (Valimaki, 2005).

The discussion of royalties on compatibility standards rests on the assumption that intellectual property applies to such standards. However, it hasn’t been, and still isn’t so clear that some form of intellectual property can really cover standards.

Traditionally, dominant software companies have relied on *secrecy* to build a time-buffer against the development of compatible and competing products. In essence, binary software distribution gives any potential competitor further tasks to analyze, disassemble and then rewrite necessary standardized parts, such as file formats, of the software before entering the markets. However, once the information is revealed, there can be no effective trade secret against third parties.

In the late 1980s and early 1990s, a major political battle was fought whether software standards could be *copyrighted*. The result crystallized in the software copyright directive from 1991, which stated that copyright protects only practical expression of computer programs (source code) and it does not reach to ideas and principles including interoperability information. Thus, compatibility standards can’t be generally copyrighted. Copyright can only

apply to e.g. specification documents but it can't prohibit in any way independent implementations of the specifications themselves.

In the early 2000s, the discussion shifted towards *patents*. The now failed directive proposal on the patenting of "computer implemented inventions" became one of the fiercest lobbying events ever. Again, the discussion was polarized with two opposite positions. The main issues were whether it was possible to have software patents at all and, if affirmative, what kind of limitations there would be for the use of software patents. One of the proposed and fiercely debated limitations was about interoperability. European parliament proposed the following kind of formulation:

"Member States shall ensure that, wherever the use of a patented technique is needed for a significant purpose such as ensuring conversion of the conventions used in two different computer systems or networks so as to allow communication and exchange of data content between them, such use is not considered to be a patent infringement." (Valimaki, 2005).

The rejection of the directive proposal has not made the interoperability issue any clearer. At the moment, one can have patents that cover for example file formats. If one wants to develop a new software product that can play popular mp3 music files or can access Microsoft's popular file systems, a patent license may be needed. It is often questioned whether these and other software patents meet the criteria of patentability and thus their validity and scope remain unclear. Indeed, for example EU commission and Microsoft seem to have opposite views of whether compatibility information in general is innovative and can embody patents:

"Microsoft considers that the software source code developed by recipients of the interoperability information that implements the Microsoft protocols should not be published under a so-called "open source license". The Commission nevertheless considers that, if the Court of First Instance rules in favour of the Commission in the pending application for annulment filed by Microsoft (case T-201/04), this should be possible for the protocols that do not embody innovations." (Valimaki, 2005).

Annex E – Total Costs of Ownership of OS solutions

TCO Component	OSS Implications	Comment
Hardware Costs Purchase Price Hardware Maintenance	OSS opens the door for more progressive use of cheaper commodity hardware (Intel running Linux) instead of proprietary hardware (RISC running Unix). For some workloads this can yield significant hardware savings, which are magnified when horizontal scaling is deployed. Savings also accrue from commercial applications moving to a commodity platform. Applications such as SAP, when moved from a proprietary platform to Intel/Linux, have yielded savings of 30 percent and more.	This discussion is very much a point in time and subject to change. Sun, IBM and HP have all significantly reduced the prices of their commodity RISC/Unix server product lines to more directly compete with Intel-based servers; this was likely fostered, in part, by competition from Linux and the fact that the vendors were seeing workloads drift from their platforms to Intel/Linux. The price per CPU for RISC servers and Intel servers has become very close in this commodity space. So from the simplistic perspective of CPU count, there are fewer opportunities for hardware cost savings. This represents a change from even two years ago. Then, and stemming back to the early days of Linux, there was a significant difference in costs between RISC and Intel platforms. But with competition and commoditization, that gap has narrowed considerably. Note: Even proprietary hardware vendors like Silicon Graphics are embracing commodity platforms, fueling the commoditization movement. In addition, some vendors have released a new lower-cost server line that competes even more directly against Intel/Linux, such as the V series from Sun. However, commodity Intel CPUs will continue to improve in price/performance at a far greater rate than RISC CPUs. Therefore, cost analyzes should start comparing equivalent processing capacities, not number of CPUs, which would swing the balance much more in favor of Intel/Linux.

Direct Software Costs	License fees do not apply with OSS; however, costs are incurred for distribution (i.e., media fees) and support. Typically, proprietary software carries a high purchase price and comparatively lower ongoing maintenance costs. The reverse is true for OSS where a commercially supported distribution is adopted: there are low to no acquisition costs but significantly higher ongoing maintenance fees.	Linux adoption can foster significant savings elsewhere, notably by moving from Unix-based software on RISC hardware to Linux on Intel hardware, which can reduce the number of CPUs required and thus license fees for software that is licensed on a per-CPU basis (e.g., Oracle). The increased Intel performance can require fewer CPUs for the same throughput. Software vendors could, however, minimize or eliminate this advantage – which today can be on the order of 30 percent savings – by changing their pricing structure.
Purchase Price Support and Maintenance	Since it is strongly recommended that enterprises purchase a commercial distribution of Linux (e.g., Red Hat or Novell/SUSE), Linux may be more expensive than Windows. It is, of course, possible to show savings with Linux if a non-commercial distribution is used, but costs will surface elsewhere (e.g., support)	Beyond Linux, savings can accrue from adopting other OSS (e.g., Apache, MySQL) instead of proprietary software. This yields significant savings in license fees. Enterprises can download the OSS or in some cases choose to buy a commercial distribution. Note that most OSS is not as volatile as Linux so enterprises may not need commercial distributions; the OSS is generally stable enough for enterprise use. Overall, OSS has increased competition and put downward pressure on ISV and software vendor pricing.
Indirect Software Costs	Usually, it is not necessary to track the number of software licenses with OSS to ensure the legality of all instances deployed. However, you still need to know where the software is deployed for security and patching purposes. That said, OSS removes the burden of having to stringently monitor software deployment.	Software audits can be quite costly. It is no small task to create and administer auditing processes that allow you to know exactly, at any time, which user is working with what software across the entire enterprise.
Administration of Licenses	It is important to have a strategy for which components should be used in the organization. This strategy must be evaluated regularly with proficient know-how of OSS components available.	
Staffing Costs	Staffing costs mirror supply and demand. Early on, Linux professionals commanded a higher rate than Windows professionals because Linux professionals were in short supply. With the spread of Linux and Linux professionals, their fees are now comparable to that of Windows professionals.	Staffing costs depend heavily on the skills of the company's IT staff. For example, if a company has been running Windows as a strategic platform for a long time and has no Linux-experienced staff, it may be quite expensive to switch to Linux, though it may pay off eventually. A company's pool of available talent plays a major role in deciding what software suits the company best.
Project Management Systems Engineering and Administrations Vendor Management Training		

Creation of Value with OS Software in the Telecommunications Field

Support Costs Installation and Set-Up Troubleshooting Support Tools, Materials Patching Peer Support Casual Learning Formal Training Application Development	Generally, Linux is less of a target to malicious hackers than Windows and thus requires far fewer security patches than Windows, but probably slightly more than Unix. Also, because Linux is a leaner operating system than Windows is today, Linux requires fewer other patches but, again, probably slightly more than Unix. A commercial distribution of Linux is well-tested before its release and has tools for automatic patching. If you are not using a commercial Linux distribution, it is hard to keep up with patches because there are so many changes made on a rapid basis. Although installation and set-up historically have been more difficult with OSS, this is no longer the case with the major OSS products that come with easy-to-use installers. Troubleshooting costs may be lower with OSS (or not). Training costs may be higher depending on the OSS in question.	Compared to older versions of Windows, Linux environments have required less effort for troubleshooting and dealing with security patches, especially given the automatic patching that is available in a professional and efficient manner for commercial Linux distributions. Microsoft says this has changed with Windows XP and Windows Server 2003, though the company has released many patches for these operating systems. Tools exist for automatically patching Linux and Windows; CSC uses these tools, which are widely available to enterprises today. Community support in the open source environment is typically very good for the major OSS products. OSS newsgroups can often respond to problems faster than commercial vendors, though there is no contractual requirement for them to be that responsive. Some proprietary software products have become so widespread that they are the de facto standard (e.g., Microsoft Office). They are well-known by most people and thus generate few support costs, generally only when upgraded. However, equivalent OSS may cause disruption in displacing commonly used products.
Downtime	The modularity of Linux can allow a very lean build to be deployed, which in turn can enable more stability and thus higher availability than a Windows environment. (Note that Unix environments are also fairly stable.)	Unplanned downtime can be as much as 50 percent of TCO. Nevertheless, downtime is often not part of a TCO analysis because its costs are difficult to quantify.

Annex F – Vision of Asterisk

1. Introduction

Asterisk is an open source converged telecommunications platform, designed to allow different types of IP telephony hardware, middleware and software to interface with each other consistently. It provides multiple layers, managing both TDM and packet voice at lower layers while offering a highly flexible platform for PBX and telephony applications such as IVR. Asterisk can bridge and translate different types of VoIP protocols like SIP, MGCP and H.323. At the same time it can provide a full-featured server platform for predictive dialing, custom IVR, remote and central office PBX and conferencing.

Asterisk project started as usually starts out many open source projects. Mark Spencer, the creator of Asterisk, found it to be too expensive for his new, support-centric *linux-support.net* business to buy a traditional PBX solution to handle phone calls. After all, one could theoretically hook up the voice lines to a computer with some sort of expansion card, and process them in software. He therefore started writing a piece of software to control such cards and perform voice switching services, in order to eliminate the need for a PBX. The result was the first version of Asterisk, which was later rewritten for modularity and flexibility, creating what we know today as the official version of Asterisk.

With his better understanding of the requirements upon developing the first Asterisk version, Mark teamed up with Jim Dixon of the *Zapata Telephony Project*, to build inexpensive expansion cards for commodity Intel-based hardware to serve as the interface of an Asterisk server platform to the PSTN. The idea was that one could buy a PC from anywhere, run Linux on it, add a card to it for some FXO/T1/E1 connections, add Asterisk to the mix, and end up with a full-featured PBX.

Making inexpensive interfaces was not easy. Traditional TDM hardware (e.g., Dialogic, later acquired by Intel) was proprietary and expensive. To achieve the goal, Mike and Jim came up with a revolutionary idea: Instead of doing the TDM processing in hardware, offload it to the host processor and let Asterisk deal with it. CPUs were becoming faster and faster, and now it would make sense to let the software use the general CPU of a commodity PC to do the TDM processing. Mark added TDM support to Asterisk, and Zapata Telephony started making pseudo TDM interfaces, which they called Zaptel. The pseudo TDM architecture provides almost the same quality and real-time capabilities of hardware TDM but at a considerably lower price and higher flexibility.

While the Zaptel interface worked well for connecting the server directly to the PSTN, there was still a need to communicate over pure IP (or later Frame Relay) in case the termination or origination of the voice session was done somewhere else. Mark did not like the bulky, proprietary H.323 protocol, so he designed his own to do the job in a very lightweight manner. IAX, or Inter Asterisk eXchange, is a protocol that takes care of both signaling and transport of packet voice between two connected nodes. Although the name implies Asterisk at both ends, IAX can in fact connect any two end points supporting the protocol. There are

phones, softphones, and phone adapters available today that speak IAX and can communicate efficiently with an Asterisk node.

Later, to support interoperability with other VoIP systems, support for other packet voice protocols like SIP, H.323, MGCP, and VoFR were added to Asterisk. With such support Asterisk is now an ideal IP PBX for environments with multiple types of phones. Millenigence has successfully used Asterisk to drive different types of IP Phones such as Siemens optiPoint 600 and Cisco 7960 (with both Skinny or SCCP and SIP firmware) as well as low budget SIP Phones such as GrandStream BudgeTone and PCPhoneLine in its DashPhone Application Server™ development lab.

2. Architecture

Asterisk follows a modular design, where different functions of the server are implemented as modules that are loaded and initialized by a run-time loader. The Asterisk core handles these items internally:

- **PBX Switching** – the essence of Asterisk is a Private Branch Exchange Switching system, connecting calls together between various users and automated tasks. The Switching Core transparently connects callers arriving on various hardware and software interfaces;
- **Application Launcher** – launches applications which performs services for users, such as voicemail, file playback and directory listing;
- **Codec Translator** – uses codec modules for the encoding and decoding of various audio compression formats used in the telephony industry. A number of codecs are available to suit diverse needs and arrive at the best balance between audio quality and bandwidth usage;
- **Scheduler and I/O Manager** – handles low-level task scheduling and system management for optimal performance under all load conditions.

Asterisk provides four basic sets of APIs for interfacing with different components:

- **Channel API** – the channel API handles the type of connection a caller is arriving on, be it a VoIP connection, ISDN, PRI, Robbed bit signaling, or some other technology. Dynamic modules are loaded to handle the lower layer details of these connections;
- **Application API** – the application API allows for various task modules to be run to perform various functions. Conferencing, paging, directory listening, voicemail, in-line data transmission and any other task which a PBX system might perform now or in the future are handled by these separate modules;
- **Codec Translation API** – loads codec modules to support various audio encoding and decoding formats such as GSM, Mu-Law, A-Law and even MP3;
- **File Format API** – handles the reading and writing of various file formats for the storage of data in the file system.

Using these APIs, Asterisk achieves a complete abstraction between its core functions as a PBX server system and the varied technologies existing (or in development) in the telephony arena. The modular form is what allows Asterisk to seamlessly integrate both currently implemented telephony switching hardware and the growing packet voice technologies emerging today. The ability to load codec modules allows Asterisk to support both the extremely compact codecs necessary for packet voice over slow connections such as a telephone modem while still providing high audio quality over less constricted connections.

The application API provides for flexible use of application modules to perform any function on demand, and allows for open development of new applications to suit unique needs and situations. In addition, loading all applications as modules makes the system flexible, allowing the administration to design the best suited path for callers on the PBX system and modify call paths to suit the changing communication needs of a going concern.

3. FreePBX

FreePBX provides a web GUI to manage an Asterisk system. It simplifies the configuration of an Asterisk platform by giving pre-programming functionality accessible by a user-friendly web interface that allows to have a fully functional PBX pretty much straight away with no programming required. Some of the features that FreePBX supports out of the box are:

- Unlimited number of voicemail boxes;
- “Follow me” functionality;
- Ring groups with calls confirmation (e.g. if a cellphone is out of range and diverts to voicemail, all the other phones keep ringing);
- Unlimited number of conferences, which is only limited by the available CPU power;
- Paging and Intercom functionality for man SIP phones that support it;
- Music on hold (via MP3s or streamed off the Internet);
- Call queues.

Using a web browser it is possible to customize a lot of features, like add sip extensions, define outbound routes and inbound routes. For example, looking to the figure F.1, we can see the interface to add sip extensions.

Figure F.1: Add SIP extensions interface

The screenshot shows the FreePBX administration interface in a Mozilla Firefox browser window. The address bar displays the URL: `http://xxx.xxx.xxx.xxx/admin/config.php?display=extensions&tech=sip`. The page title is "freePBX™". The top navigation bar includes links for "Setup", "Tools", "Reports", "Panel", and "Recordings". The user is logged in as "admin" with a "logout" link. The sidebar on the left contains a list of modules: "Module Admin", "Conferences", "On Hold Music", "Digital Receptionist", "Extensions" (highlighted), "Inbound Routes", "Outbound Routes", "Trunks", "General Settings", and "Administrators". The main content area is titled "Add SIP Extension" and contains the following fields and options:

- Add Extension** (Section Header)
- Extension Number:**
- Display Name:**
- Extension Options** (Section Header)
- Outbound CID:**
- Emergency CID:**
- Record Incoming:**
- Record Outgoing:**
- Device Options** (Section Header)
- secret:**
- dtmfmode:**
- Voicemail & Directory:**
- Submit** (Button)

Source: Lally, 2007

The above interface can be used for the following tasks:

- Creation or modification of local phones;
- Each one gets an individual extension number and name;
- Configures voicemail settings for each extension.

4. Trixbox

Beginning in 2004 as Asterisk@Home, the Trixbox telephony application platform is the open source software that has quickly become the most popular Asterisk-based distribution in the world. Trixbox combines the best of open source telephony tools into one easy-to-install package, along with the trixbox dashboard which provides a web-based interface to configure and manage a complete IP-PBX system.

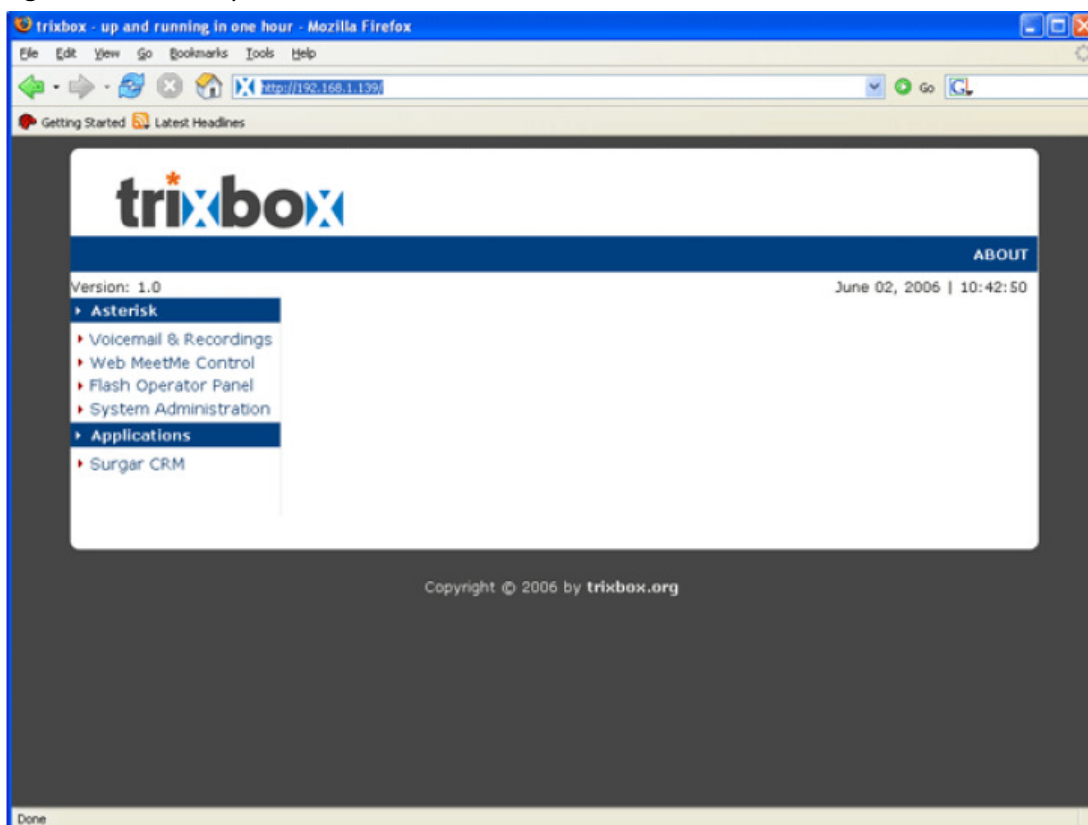
The Trixbox solution combines FreePBX with several other components in a single package:

- CentOS Linux;

- SugarCRM contact management;
- MySQL;
- HUDlite management console;
- Asterisk Recording Interface (ARI)
- Java SSH terminal
- phpMyAdmin.

Like the FreeBox standalone solution, it's possible to use a web browser to configure its proprieties. For example, looking to the figure F.2, we can see the interface of Trixbox system administration.

Figure F.2: Trixbox system administration interface



Source: Lally, 2007

The above interface is the system administration menu, where we can perform the following tasks:

- Config edit files;
- See Asterisk status summary;
- Use HUD management console;
- Maintain MySQL database.

5. Callweaver – “Open PBX”

CallWeaver (formerly known as OpenPBX.org) is a community-driven vendor independent cross-platform open source PBX software project. It was originally derived from Asterisk, a Linux software PBX.

Many Asterisk users and developers have experienced the impact of Digium tightly exercising control over Asterisk for their own business interests, increasingly at odds with the common interest of the community of users, developers and other parties who have largely contributed to the project becoming popular in the first place.

As a result more and more users, developers and integrators agreed that a strong alternative to the Asterisk project which would take its own direction would be beneficial and desirable as long as such a project would be not controlled by a single vendor and would be managed for the common interest of users, developers and vendors who would use it.

CallWeaver was forked from the Asterisk 1.2 code base to develop and maintain just such an alternative. CallWeaver has its own objectives, different from those of the Asterisk project. In particular, CallWeaver is characterized by the following:

- Different points of view are welcome, politics and censorship are frowned upon;
- A project charter and mindset that always rates reliability and cross-platform compatibility over features;
- A commonly shared view that Asterisk design is broken and structural rework is needed;
- A preference for generic solutions and reuse of freely available libraries;
- Ability to embed or link to any available GPL compatible library due to the absence of dual licensing;
- Contributors to the project do not need to sign disclaimers to assign rights in their contributors to other parties.

CallWeaver supports all major PSTN technologies in use today: analog telephone lines (POTS), MFC/R2 via Unicall and Basic Rate ISDN (BRI). Also several ISDN protocols stacks are available for use with CallWeaver. Besides that, it supports a variety of voice over IP protocols: H.323, IAX2, MGCP and SIP.

The CallWeaver solution led to the following improvements over Asterisk:

- Removal of all Zaptel hardware timer dependencies and use of software timers (either kernel based or generic) in their place;
- Replacement of Berkeley DB 1.0 with SQLite 3 as engine for the internal key/value database;
- Replacement of internal DSP with superior DSP provided by the SpanDSP library;

- Support for STUN, T38 fax over IP and a universal jitter buffer;
- Much faster and more efficient dialplan execution;
- Much faster and more efficient extension matching engine;
- Fixing of bugs which Digium did not acknowledge.

Annex G – Vision of SIP

1. Introduction

The Session Initiation Protocol (SIP) is an Internet Engineering Task Force (IETF) standard protocol for establishing, manipulating and tearing down an interactive user session that involves multimedia elements such as audio, video, instant messaging or other real-time data communications. Even though H.323 was the first protocol to introduce VoIP, analysis estimate that SIP will play a major role in the coming years and will replace H.323 in VoIP applications.

SIP is a request-response protocol that works in the application layer of the Open Systems Interconnection (OSI) communications model, and provides the capability to:

- Determine the location of the target end point. SIP supports address resolution, name mapping and call redirection;
- Determine the media capabilities of the target end point, via Session Description Protocol (SDP). SIP determines the “lowest level” of common services between the end points. Conferences are established using only the media capabilities that can be supported by all end points;
- Determine the availability of the target end point. If a call cannot be completed because the target end point is unavailable, SIP determines whether the called party is already on the phone or did not answer in the allotted number of rings. It then returns a message indicating why the target end point was unavailable;
- Establish a session between the originating and target end point. If the call can be completed, SIP establishes a session between the end points. SIP also supports mid-call changes, such as the addition of another end point to the conference or the changing of a media characteristics or codec;
- Handle the transfer and termination of calls. SIP supports the transfer of calls from one end point to another. During a call transfer, SIP simply establishes a session between the transferee and a new end point (specified by the transferring party) and terminates the session between the transferee and the transferring party. At the end of a call, SIP terminates the sessions between all parties.

SIP normally runs over UDP or TCP, but it can run over other protocols such as IP, ATM or X.25. It requires only a datagram service and is independent of the packet layer. It can provide “out-of-band” call setup services in which the SIP exchanges take place over UDP or TCP, but actual data transmission takes place over the public telephone network.

An important feature of SIP is that it does not define the type of session that is being established, only how it should be managed. This flexibility means that SIP can be used for an enormous number of applications and services.

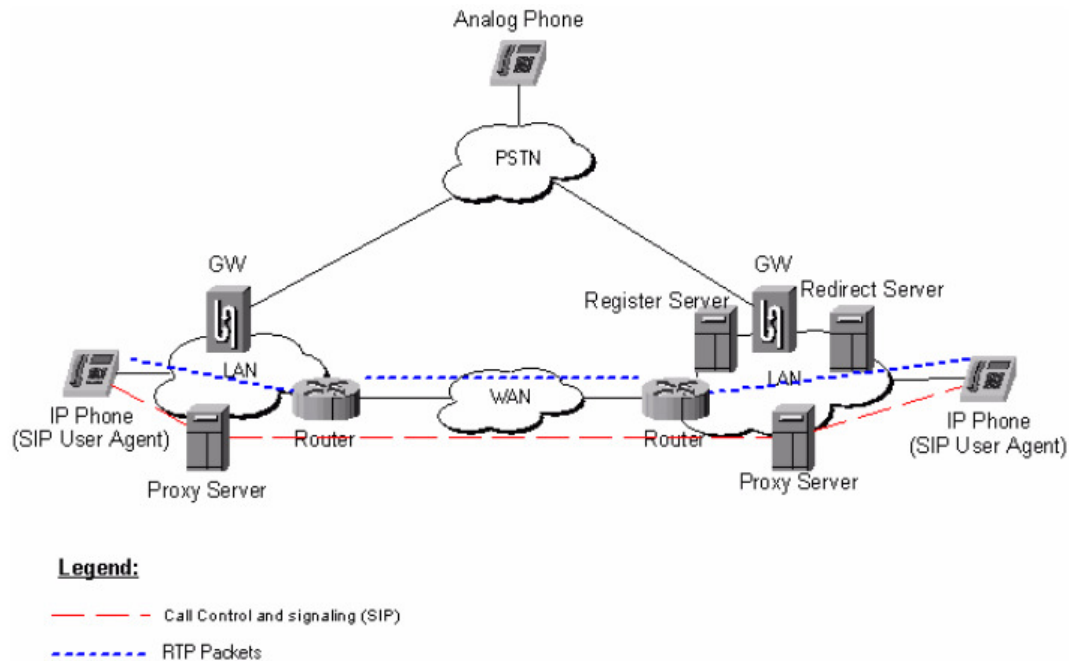
Below are some of other SIP features that distinguish it among new signalling protocols:

- SIP messages are text based and hence are easy to read and debug. Programming new services is easier and more intuitive for designers;
- SIP re-uses several existing and mature internet services and protocols such as DNS, RTP, RSVP, etc. No new services have to be introduced to support the SIP infrastructure, as much of it is already in place or available off the shelf;
- SIP extensions are easily defined, enabling service providers to add them for new applications without damaging their networks. Older SIP-based equipment in the network will not impede newer SIP-based services. For example, an older SIP implementation that does not support method/header utilized by a newer SIP application would simply ignore it;
- SIP is transport layer independent. Therefore, the underlying transport could be IP over ATM. SIP uses the User Datagram Protocol (UDP) as well as the Transmission Control Protocol (TCP) protocol, flexible connecting users independently of the underlying infrastructure;
- SIP supports multi-device feature levelling and negotiation. If a service or session initiates video and voice, voice can still be transmitted to non-video enabled devices, or other device features can be used such as one way video streaming.

2. Architecture

The SIP architecture identifies two basic components:

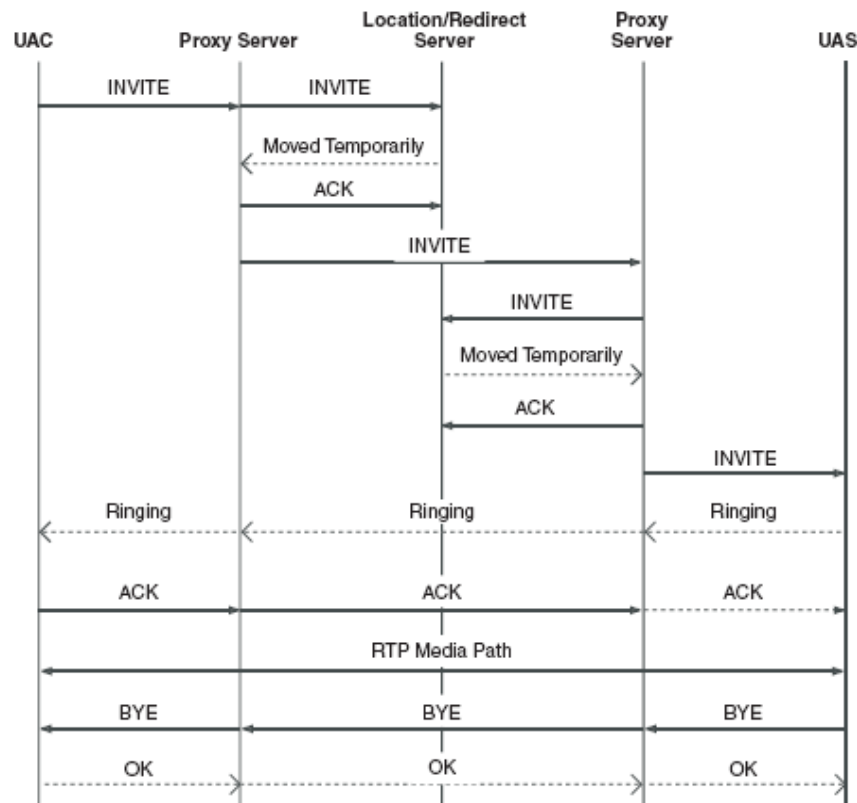
- SIP User Agent(UA) – the basic endpoint component, which can be represented by a hardware or software device implementing SIP (e.g., an IP phone), and consists of two main components: User Agent Client (UAC) and User Agent Server (UAS). UAC is responsible to initiate the calls and UAS to answers them;
- SIP Network Server – handles signaling associated with multiple calls providing name resolution and user location. It consists of three main groups: SIP Register Server, SIP Proxy Server and SIP Redirect Server. SIP Register Server receives registration messages from endpoints regarding current user location and maps the SIP addresses with the physical location(s) in the domain where the endpoint is located. These mapping data are stored in a database which can reside on the same machine or on a remote server. SIP Proxy Server forwards the SIP messages to multiple proxy servers, creating a search tree, in order for the SIP messages to reach their destination. There are two different operating models for these servers: stateless (the server forgets all the information once the request is sent) and stateful (the server save previous routing information and is able to use it for improving the message transfer). Finally, SIP Redirect Server helps endpoints to find the desired address by redirecting them to try another server.

Figure G.1: SIP architecture

Source: Ixia, 2004

Also, the diagram in figure G.2 illustrates a basic SIP call setup scenario, using the following messages:

- INVITE – initiates session. The session description is included in the message body. RE-INVITE is used to change session state;
- ACK – confirms session establishment and can be used only with INVITE;
- BYE – terminates session;
- CANCEL – cancels a pending INVITE;
- OPTIONS – capability inquiry;
- REGISTER – binds a permanent address to current location and it may convey user data.

Figure G.2: Basic SIP call setup scenario

Source: Ixia, 2004

If a call is to be routed through a number of different proxy servers, the redirect server is used. When a caller UA sends an INVITE request to the redirect server, the redirect server contacts the location server to determine the path to the called party, and then the redirect server sends that information back to the caller. The caller then acknowledges the reception of the information.

The caller then sends a request to the device indicated in the redirection information (which could be the callee or another server that will forward the request). Once the request reaches the callee, it sends back a response and the caller acknowledges the response. RTP is used for the communication between the caller and the callee.

3. Applications

SIP has been described as “a simple protocol with profound implications”. It addresses many of the major issues of the development of Internet telephony, a technology that is predicted to change the way businesses and people talk to each other. The main applications implemented with SIP are:

- Unified Communications – a SIP session can contain any combination of media (voice, data, video, etc.). These sessions can be modified at any time by adding new parties or by changing the nature of the session. SIP allows browsers to become augmented with

multimedia capability. Using SIP, simple, but very powerful services, like click-to-dial, become possible. User profiles can be managed through a web interface and voice plug-ins are incorporated into browser technology. SIP uses MIME, the facto standard for describing content on the Internet, to convey information about the protocol used to describe the session and has an URL-style addressing system. It uses the Domain Name System (DNS) to deliver requests to the server that can appropriately handle them;

- Unified Messaging – e-mail, voice-mail, faxes and phone messages are accessible from the same box. Alternatively, people use many different devices to communicate. Unified messaging helps people that use different communication devices, media, and technologies to communicate at any time and under their own control;
- Directory Services – directory services are to a network what white pages are to the telephone system. They store information about things in the real world, such as people, computers, printers, and so on, as objects with descriptive attributes. People can use the service to look up objects by name, or like the yellow pages, they can be used to look up services. Network managers use directories to manage user accounts and network resources. From a manager's viewpoint, a directory service is like an inventory of all the devices on the network. Any device can be located by using a graphic interface or by searching for its name or some properties (e.g., "color printer"). Once located a manager can control the device (e.g., disable it or block certain users from accessing it). The directory is a central database where all objects and users are managed;
- IP-PBX functionality – software based IP-PBX that is compliant with the SIP standard can be utilized in a single office setting or multiple office locations, offering flexibility and options for future expansions;
- Voice-enhanced e-commerce – a website contains click-to-dial links that establish a session between the end-user and the website organization. This kind of service could be a part of a value-added web-hosting service offered by a service provider or it could be developed by and enterprise's IT department;
- Web Call Centers – a web page may be the propped when a particular number is called (with SIP, it is just as easy to direct an user to a web page as it is a telephone). SIP supports IVR (Interactive Voice Response) features, navigating users through options and providing auto-responses to common requests. In addition, SIP's forking facility is perfect for fulfilling the ACD (Automatic Call Distribution) function;
- Instant Messaging (IM) and Presence – because a SIP session can consist of any form of communication, it is possible to promote an IM session to a telephone call or even a whiteboard or video session at the click of a button. It is also easy to invite other people to join your session, creating spontaneous conference calls. Using third party call control, a conference service could even check the presence status of people due to join a conference and when all parties are available it could establish the session by connecting them all to a conference bridge.

Presence goes hand-in-hand with the evolution of voice services. A network that has dynamically updated information about an user's preferences and availability can perform more intelligent call routing than today's PSTN or existing find-me/follow-me services.

4. sipX

The sipX is a next generation IP PBX solution offering rich functionality combined with ease of use, installation and administration. sipX is entirely based on the Session Initiation Protocol (SIP) and significant attention is paid to standards compliance and interoperability.

The sipX project team did not set out to primarily build a soft PBX. At the time the IETF started to standardize SIP, a much more significant idea was at the core of leading thinker's minds: to establish real-time communications as a core capability of the Internet. Like email, they thought, it should be possible to exchange real-time messages (voice, IM, video) across the Internet and based on a global addressing scheme – the SIP URL. Like an email server, when we want to send and receive real-time sessions we need a SIP Proxy. sipX, therefore, is a SIP Proxy that, when deployed, “real-time enables” an Enterprise.

sipX is a fully distributed system that actually consists of 9 independent server components:

- Configuration server;
- Forking proxy server;
- Authentication proxy server;
- Registrar, status and presence servers;
- Call park, media and conferencing servers.

Communication between these servers is based on standard protocol (sockets) such as SIP, HTTP and XML RPC. While all the components of sipX can be installed and run on one physical server, significant progress has been made towards a fully distributed system.

All configuration data (users, devices, permissions, dial plans, credentials, group policy, CDR data, etc) are stored in a Postgres database.

Media and signaling are strictly separated as mandated in the SIP standard. Having media and signaling go through the same server would not only impose significant performance limitations; it also creates an unacceptable single point of failure.

A distributed architecture is also natural for load-balancing, performance scalability and fail-over. In recent versions the sipX project introduced high-availability with a fully redundant call control system (proxy and registrar). Under normal operating conditions the redundant systems will share load. Registration state information is automatically and in real-time synchronized between redundant registrars, creating one big system from a user perspective. This feature is normally only seen in expensive large enterprise systems.

The sipX works with any network connected FX/FXS gateway from any vendor and allows for flexible rules based call routing using different gateways in different locations, including automated fail-over in case a gateway is temporarily unavailable.

The issue relating the ease of use and installation is a critical design goal for sipX. All system administration and configuration is done using a web interface provided by configuration server. Configuration server is an integral component of the system and therefore data consistency is always maintained. The admin should not be required at any time to use a Linux command line or edit config files. Configuration server also provides a Web services API based on SOAP. In addition, user & device configuration data can be bulk uploaded from a CSV file, generated by a spread sheet application.

The sipX provides a defined upgrade path that includes automated data migration as the system is upgraded from release to release. In case of database schema changes automated scripts are invoked to migrate the configuration data.

Also, the sipX provides a plug & play management for an increasing number of peripheral devices such as phones and gateways. A simple XML based plug-in interface is available that can be used to easily add support for new devices. As such, the sipX configuration server replaces the management interface provided by the phone or gateway and allows all configuration to take place remotely. A high level of abstraction is provided where users can be assigned to devices, device and user properties are managed in groups with inheritance, and the management capability goes as far as including firmware upgrades for the devices. Device configuration data is stored and backed up centrally as part of the sipX system.

Annex H – Netcall Documents

1. Interview – Netcall

Contact: Eng^o Helder Ribeiro (responsável pelo depart. técnico)

1. Como foi desenvolvido o sistema de VoIP internamente na vossa empresa? Existiu uma equipa técnica dedicada a 100%? Qual foi a vossa metodologia de trabalho?

Esta ideia surgiu a partir do nosso primeiro projecto na área de criação de CallCenters e da aplicação do conceito AllôShop. Na altura, tínhamos um forte interesse em iniciar a nossa actividade na área de voz sobre IP, pois temos a noção que no futuro a grande maioria das comunicações de voz vão ser efectuadas por IP. Nós queríamos estar na frente da implementação deste conceito e por isto estabelecemos desde o início uma equipa dedicada a 100% na concretização desta iniciativa.

Paralelamente, tivemos desde muito cedo a noção que o VoIP, só por si, não seria rentável, pelo menos no curto-prazo. Foi necessário proceder ao desenvolvimento de diversos serviços na área de voz sobre IP. São estes serviços que nos vão permitir extrair rentabilidade do VoIP.

2. Qual é a plataforma que serve de base à vossa solução?

Nós usamos diversas plataformas no segmento open-source e comercial. A nossa plataforma de VoIP tem por base uma solução desenvolvida pela InterTalk, bem como o nosso sistema de billing que também tem por base uma solução comercial.

Usamos soluções de open-source para criar diversos serviços sobre IP, nomeadamente ao nível do sistema de numeração, PBX e Fax. Para além disto, usamos o Joomla como plataforma principal na concepção de websites.

Optamos por usar uma plataforma de VoIP comercial, pois não queríamos perder o “time-to-market” e colocar rapidamente uma solução VoIP no mercado. Na altura ainda pensamos em usar uma solução open source, mas tal iria provocar um tempo considerável em termos de personalização da solução.

3. Quais foram os principais obstáculos encontrados?

Foi necessário adaptarmo-nos à plataforma de VoIP comercial. Este tempo foi menor do que no caso de uma solução open-source, mas aí tivemos que fazer uma análise inversa das funcionalidades que iriam estar disponíveis para os nossos clientes. Foi necessário partir de uma solução já existente e construir novos serviços de valor acrescentado.

4. Quais são as principais alterações que a vossa solução tem sofrido desde que se encontra no mercado?

No início a nossa rentabilidade encontrava-se ao nível do tráfego IP mas, pouco a pouco, fomos integrando novos serviços. Foi ao nível dos serviços que se encontram as principais alterações da nossa solução ao longo do tempo.

5. A empresa endereça as suas soluções para o mercado empresarial ou residencial?

O nosso principal foco é o mercado empresarial em território nacional e nos PALOPs, como Angola, Cabo Verde e Brasil.

Temos consciência porém que temos vários clientes residenciais, mas este não é o nosso mercado alvo, pois este não é um mercado especialmente lucrativo, pois tem a concorrência de grandes operadores nacionais e internacionais.

6. Quais são as mais valias das vossas soluções, nomeadamente na área de VoIP, face a outras existentes no mercado?

Pelo facto de sermos um operador VoIP temos a vantagem de estar ao longo de toda a cadeia de valor do VoIP. Estamos próximos dos fornecedores dos equipamentos e hardware, mas temos contacto com o utilizador final e sabemos atender as suas necessidades. Alguns destes fornecedores acabam por ser nossos parceiros.

7. Como é realizada a transferência de uma solução de comunicação tradicional para o NetcallVox?

Nós não seguimos uma metodologia base que serve para todos os nossos clientes. Sabemos que cada cliente tem as suas especificidades e necessidades na área de comunicação e pretendemos entender todos os seus requisitos. Um dos aspectos mais importantes para nós é fazemos um levantamento dos requisitos junto dos nossos clientes.

A arquitectura das nossas soluções contempla uma grande flexibilidade e pode incluir unicamente soluções de “hosted” nos nossos serviços ou a integração de diversos serviços junto do cliente.

8. Como é feita a negociação do preço a pagar por cada chamada (nacional/internacional)?

O preço a pagar por cada chamada depende da ligação com os providers que são estabelecidos. Nós, à partida, estabelecemos uma lista de providers de preferência, que é baseada na sua fiabilidade, preço e qualidade.

Para além disto, usamos a lista de providers que a InterTalk já possui, o que nos permite ter condições em termos de preço mais vantajosas.

9. É possível ao utilizador definir um “trade-off” entre o custo da chamada e a sua qualidade?

Sim, mas unicamente para utilizadores de alguma dimensão. À partida, usamos a que apresenta um custo mais baixo.

Para além disso, gostaria de realçar que a qualidade das chamadas VoIP depende dos “codecs” de comunicação que são usados e também da largura de banda que se encontra disponível junto do cliente.

10. Como funciona o sistema de numeração Netcall30? Quais são as suas principais vantagens?

Este novo sistema de numeração permite receber e fazer chamadas para qualquer operador e tirar partido da redução de custos de comunicação entre equipamentos VoIP. Dentro da mesma rede NetCall, os custos das chamadas são grátis e dentro da rede “30” de outros operadores, estes custos são também relativamente reduzidos.

Para além disto, gostaria de realçar que a NetCall não inclui qualquer custo de activação.

11. Quais são as mais valias da vossa solução integrada Greenbox?

Esta ideia surgiu a partir da solução da edgeBox. Inicialmente nós éramos revendedores da edgeBox, mas depois verificamos que esta solução era pouco versátil e personalizável. A edgeBox contempla um grande número de serviços, mas não é fácil incluir novos serviços e adaptá-los ao cliente. Assim, optamos por criar a nossa GreenBox que é uma solução única na área de voz sobre IP que já suporta os principais serviços adicionais ao nível de gestão de rede e PBX.

12. Qual é a razão de a empresa apostar também na solução NetcallWeb, na área de criação e gestão de websites?

Neste momento esta deixou de ser uma área prioritária para nós. A criação de websites e a manutenção dos nossos clientes neste domínio passou para os nossos parceiros que actuam nesta área. Contudo, ainda temos a necessidade de manter algum suporte para alguns clientes específicos.

13. Qual é a importância relativa das diversas soluções disponibilizadas pela Netcall? Quais são as duas mais importantes? E a menos importante?

Diria que a área mais importante para nós é o VoIP, os serviços que conseguimos disponibilizar, o novo sistema de numeração do hardware.

O menos importante é a área de criação e gestão de websites que se encontra a ser descontinuada.

14. Que suporte técnico garante a empresa?

Nós disponibilizamos suporte de 1ª e 2ª linha. A 1ª linha consiste num atendimento por helpdesk e a 2ª linha pode contemplar suporte remoto ou deslocações às instalações dos nossos clientes.

15. Quais são os vossos principais clientes? Existem casos de estudo?

Os nossos principais clientes encontram-se na área de call-centers, empresas de construção civil e escritórios de advogados. Destaco os seguintes clientes:

- Grupo Amorim;
- Mota Engil;
- Teixeira Duarte;
- Eurovoice.

16. Quais são os meios usados pela empresa para divulgar os vossos produtos?

Nós não investimos muito em publicidade. O nosso principal meio de divulgação das várias soluções da Netcall é o nosso website. Aliás, investimos bastante no nosso website como principal veículo de comunicação junto dos clientes.

Para além disso, trabalhamos com algumas agências de publicidade, no qual são lançados diversos “press-releases”.

Uma outra forma de promoção dos nossos produtos é efectuada pelos nossos agentes que comercializam a nossa solução. São muitas vezes estes agentes que se encontram mais próximos dos nossos clientes finais.

2. Distinctive competencies

Empresa: Netcall

Competências Centrais	Validação		Comentários
	Sim	Não	
Personalização da solução	Sim		A solução a implementar depende da análise de requisitos efectuada junto do cliente.
Parcerias com fornecedores e distribuidores	Sim		
Parcerias com empresas desenvolvedoras de software	Sim		Ao nível do segmento comercial.
Parcerias com Telcos	Sim		
Conhecimento profundo da área de negócio VoIP	Sim		
Conhecimento profundo da área de tecnologias de rede e multimédia		Não	
Reputação da marca	Sim		Que é difundida pelos seus agentes que se encontram mais próximos do cliente final.
Recursos técnicos ao nível de segurança		Não	
Equipa interna de I&D		Não	
Construção de soluções independentes do sist. operativo do cliente		Não	
Qualificação da equipa técnica		Não	
Testes e avaliação do código		Não	
Aposta na optimização da solução desenvolvida		Não	
Suporte técnico fornecido ao produto		Não	
Integração de várias soluções no domínio open source e comercial	Sim		Ao nível de integração de novos serviços baseados em open-source sobre uma solução base VoIP comercial.
Robustez da solução desenvolvida		Não	
Escalabilidade da solução		Não	
Uso de tecnologias inovadoras		Não	
Rede de contactos da empresa	Sim		Boa rede de parceiros, tanto a nível de fornecedores com agentes.
Perfil e experiência dos seus colaboradores	Sim		
Interface gráfica com o utilizador		Não	
Foco na usabilidade da solução		Não	

3. Other documents

Posicionamento da Netcall face à concorrência

Concorrência	Realidade
	- Sem presença em Portugal - Sem numeração nómada (Netcall30) - Elevada dependência de computador (uso exclusivo de Softphone) - Pagamentos por VISA - Sem apoio ao cliente
	- pouco interessados em investir seriamente numa tecnologia que implica perda de receita - combater nas margens, mas não na versatilidade do serviço; - modelos de negócio somente orientados para a Voz;
	- Tarifários pouco competitivos - Baseados em Softphone ou equipamentos pouco avançados (e.g., telefones IP, ATA); - Pouca diferenciação face a outros players (e.g. Skype); - Sapo, Telepac e TV Cabo só funcionam na rede PT

			
Segmentos	Residencial, SoHo, PME's e Corporate	Residencial	Residencial
Facturação	Uma empresa pode gerar uma só factura mesmo que tenha vários números em utilização.	Cada número de telefone gera uma factura independente	Cada número de telefone gera uma factura independente
Apoio ao cliente	Email; telefónico; presencial	Faq's	Fóruns
Oferta	baseada na Voz (VoIP) e nos serviços sobre IP (SoIP)	baseada na Voz e não no serviço	baseada na Voz e não no serviço
Consumos de largura de banda	Só quando o serviço está a ser utilizado	Sempre que o serviço está ligado, mesmo sem estar a ser utilizado	Sempre que o serviço está ligado, mesmo sem estar a ser utilizado
Limitações de chamadas	Não	Não	Não
Numeração Nómada	Sim (Netcall30)	Não	Não
Tipos de Pagamento	MB, VISA e transferência Bancária	VISA	VISA
Taxas de activação	Não	Sim	Não
Tarifário	☺☺	☺	☺☺

☺ - tarifário não-competitivo

☺☺ - tarifário competitivo

☺☺☺ - tarifário muito competitivo

Tarifário Netcall (em 20/03/2008)

Destino	Preço (euros)
PORTUGAL	0.017
PORTUGAL - 112 e Numeros 800 xxx xxx	0.000
PORTUGAL – Mobile	0.170
PORTUGAL - Numero 118	0.385

Creation of Value with OS Software in the Telecommunications Field

PORTUGAL - Numeros 707 xxx xxx	0.100
PORTUGAL - Numeros 760 xxx xxx	0.600
PORTUGAL - Numeros 808 xxx xxx	0.070
África do Sul	0.069
África do Sul - Móvel	0.189
Angola	0.179
Angola - Móvel	0.227
Austrália	0.017
Austrália – Móvel	0.189
Brasil	0.044
Brasil - Móvel	0.211
Brasil - Rio de Janeiro	0.017
Brasil - São Paulo	0.017
China	0.017
China - Móvel	0.017
Cuba	1.235
Espanha	0.017
Espanha – Móvel	0.234
Roménia	0.101
Roménia - Móvel	0.236
Rússia	0.040
Rússia – Móvel	0.061

Annex I – NextStag Documents

1. Others documents

NextStag support

Comparison	Silver	Gold	Platinum
Ideal Usage	Silver support package is the lowest level of support that is appropriate for organizations that have a strong and experienced IT team and require minimum support assistance.	Gold support package is the middle level of support that includes certain free visits from NextStag™ engineers along with priority responsiveness.	Platinum support package is the highest level of support that includes complementary Professional Services along with top-priority response and free visits from NextStag™ engineers.
Phone Support	✗	✓	✓
Chat Support	✗	✓	✓
Email Support	✓	✓	✓
Engineer Visit	✗	✓	✓
Pre-emptive alerts	✗	✓	✓
Scheduled CleanUps & Maintenance	✗	✓	✓
Ticketing Support	✓	✓	✓

1- 8 hours

2- 24 hours

3- Only normal cleanups excluding database

4- Alerts for system

5- Alerts for operations and system

Annex J – VipVoz Documents

1. Interview – VipVoz

Contact: Engº Francisco Fernandes (CEO of VipVoz)

1. Como foi desenvolvido o sistema de VoIP internamente na vossa empresa? Existiu uma equipa técnica dedicada a 100%? Qual foi a vossa metodologia de trabalho?

A ideia de criar um sistema de VoIP teve como base o encontrar de uma solução de comunicação que fosse de encontro a uma nossa necessidade latente. A VipTrade, a nossa companhia têxtil, tratava essencialmente da importação de artigos e matérias primas oriundas da Ásia. Na altura, um dos nossos custos mais importantes centrava-se nos custos de comunicação internacionais. As chamadas para a Ásia eram muito caras e os operadores tradicionais não ofereciam um tarifário competitivo.

Paralelamente, começava a surgir no mercado o Skype. A empresa desde o início viu neste projecto como uma alternativa ao uso dos operadores tradicionais e como uma forma de diminuir os custos de comunicação. Contudo, o skype, apesar de nós sermos um conjunto de colaboradores oriundos da área técnica apresentava um conjunto de inconvenientes como era a necessidade de usar headphones, a qualidade de voz era baixa e não existiam rotas alternativas para o encaminhamento das chamadas.

Na altura, e motivado pelas nossas competências técnicas na área de “networking”, viu-se com bons olhos a possibilidade de se conceber internamente uma solução de VoIP com base numa plataforma open source. Na altura, uma das soluções que nos pareceu mais interessante foi o Asterisk. Simultaneamente, e para fazer face à nossa necessidade imediata decidiu-se pela aquisição de uma solução de VoIP comercial chamada SIS Master. Esta solução possibilitou-nos também extrair algum conjunto de funcionalidades que seriam interessantes de se implementar na nossa solução. Foi, sem dúvida, uma boa base de trabalho.

2. Qual é a plataforma que serve de base à vossa solução?

Como foi dito na resposta anterior, a VipVoz optou por usar o Asterisk, o que se revelou acertado, pois é a solução open source mais usada por diversos projectos de outras empresas nesta área. Para além disto, a VipVoz usa outras ferramentas open-source na concepção das suas soluções, nomeadamente:

- Asterisk;
- OpenSer;
- MySQL;
- SIP;
- Python.

A VipVoz só usou plataformas 100% open source. Esta foi uma decisão tomada logo à partida do projecto.

3. Quais foram os principais obstáculos encontrados?

Diria que o principal obstáculo encontrado diz respeito à falta de suporte do modelo open source, para além do seu modelo aparentemente “caótico” de desenvolvimento. Na altura o projecto Asterisk não se encontrava tão desenvolvido como se encontra agora, e os seus

produtos não tinham um bom conjunto de documentação técnica nem uma interface gráfica “user-friendly”.

O único suporte que existia eram os fóruns de discussão e os chats de IRC. Sem dúvida, que aí encontramos informação preciosa, mas era preciso estar dentro do meio e saber como todo este processo funciona. Na altura, sentimo-nos um pouco perdidos, mas pouco a pouco, e devido às nossas competências técnicas e vontade de aprender, foi nos possível conceber um protótipo que foi testado aqui na empresa.

4. Que alterações sofreu a vossa solução inicial até ser colocada no mercado?

Do ponto de vista técnico a nossa solução permaneceu praticamente inalterada face à versão de demonstração internamente aqui testada. Contudo, para se colocar uma solução destas no mercado foi necessário dar uma particular atenção ao nível do design e em termos de “billing”. Foram sobretudo desenvolvidas funcionalidades na área de extranet, portais web e facturação detalhada.

Na altura tentamos criar uma solução que fosse totalmente compatível com outras centrais telefónicas de PSTN, nomeadamente com a Alcatel. Contudo, tal não foi possível, apesar de algumas tentativas nossas, devido à Alcatel não seguir as normas standard RFC em termos de protocolos de comunicação e IMS.

5. Quais são as razões para a empresa apostar em vários tipos de serviços, para além do VoIP?

A VipVoz é uma PME e não possui um volume de negócios que lhe permita centrar a sua atenção num único segmento de mercado. Optamos por diversificar a nossa oferta e criar uma estreita relação com o cliente. Novos clientes são difíceis de obter e muitas vezes é mais simples vender soluções complementares na área de sistema de informação a uma mesma empresa.

Para além disso, o mercado português é bastante conservador e na altura o mercado de VoIP era muito reduzido e olhado com muita desconfiança pelas empresas. Praticamente nenhuma empresa se iria meter numa aventura de introduzir o VoIP, sem ter a certeza que isto iria trazer inegáveis benefícios para a empresa. Economicamente não seria viável oferecer unicamente uma solução de VoIP. Acredito que agora com a crescente utilização do VoIP este segmento de mercado, só por si, já se torne mais apetecível.

Por último, internamente nós temos uma equipa com excelentes qualificações técnicas e com profundos conhecimentos na área do open-source. Seria para nós também interessante oferecer outras soluções com base em produtos open-source que fossem complementares ao projecto de voz inicialmente definido.

6. Qual é o motivo de focarem exclusivamente no mercado empresarial?

A VipVoz foca-se exclusivamente no mercado empresarial por três razões:

1. Temos um corpo técnico de grande qualidade que contempla cerca de 90% dos recursos humanos da empresa. Nós fomos técnicos e temos uma maior apetência para lidar e trocar informação com técnicos de outras empresas.
2. Seria necessário possuir-se outro tipo de suporte técnico caso se optasse pelo mercado residencial. Por exemplo, seria necessário ter uma área de helpdesk, algo que neste momento não possuímos;

3. A estratégia da VipVoz não passa por efectuar uma concorrência com base no preço. Tal como o nome da empresa indica nós fomos “Vip”. Oferecemos um serviço de qualidade a empresas com preços um pouco superiores aos da nossa concorrência, mas os nossos clientes estão dispostos a pagar este preço extra para obter um serviço de qualidade.

7. Existe alguma brochura ou panfleto sobre o VIP Connect?

Neste momento não tenho nenhuma nas nossas instalações. Estamos a reformular estes mesmos panfletos. Envio-lhe por email em breve as novas brochuras da VIP Connect.

8. Quais são as mais valias do VIP Connect, face a outras existentes no mercado empresarial?

Eu diria que as nossas mais valias se situa ao nível do tratamento dado ao cliente e o suporte técnico que lhe é oferecido. Qualquer questão levantada por um dos nossos clientes é prioridade para nós.

Para além disso, a arquitectura da nossa solução, apesar de não ser inovadora, apresenta inúmeras mais valias para o cliente. Uma dessas grandes mais valias passa pela introdução do VoIP de uma forma faseada, sem ser necessário efectuar-se alterações na estrutura de comunicações do lado do cliente.

9. Como é realizada a transferência de uma solução de comunicação tradicional para o VIP Connect?

É mesmo muito simples. A VipVoz desloca-se às instalações do cliente e instala o seu sistema Vip Connect que consiste numa “gateway”. Nos servidores da VipVoz é efectuada o “routing” dessas chamadas provenientes desta nova origem. A partir deste momento o tráfego pode ser encaninhado tanto por VoIP, como PSTN ou GSM.

10. Como é feita a negociação do preço a pagar por cada chamada (nacional/internacional)?

Este preço é pré-estabelecido pelos vários “providers” e “brokers” a actuar no mercado. Nós não temos grande margem de manobra, apesar de podemos fazer descontos para clientes específicos, dependendo do seu volume de comunicações. Simultaneamente, acompanhamos sempre o preço da nossa concorrência e podemos afirmar que estamos num patamar similar.

11. É possível ao utilizador definir um “trade-off” entre o custo da chamada e a sua qualidade?

Sim. A Vip Connect tem em conta esta situação. Só disponibilizamos ligações a “brokers” de tráfego VoIP disponibilizados por operadores que asseguram uma boa qualidade de serviço, como é o caso da PT e da ONI. Desta forma, a qualidade das nossas chamadas é sempre média e alta.

Para garantir mecanismos de QoS do lado do cliente, o nosso equipamento dá preferência na entrega de pacotes de informação contendo voz. Sabemos que o envio de pacotes de dados contendo voz deve ser prioritário relativamente a outros pacotes, como tráfego de email.

Para além disso, e para clientes mais exigentes, podemos encaminhar o tráfego por brokers que oferecem uma maior qualidade de serviço. Este tipo de situações tem que ser negociado

pela empresa e possivelmente resultará num acréscimo dos preços de comunicação para o cliente.

12. Que suporte técnico garante a empresa?

Nós disponibilizamos apoio técnico em horário alargado (das 9h às 19h). Para clientes de maior dimensão sabemos que temos que estar disponíveis 24 horas por dia e 7 dias por semana.

Uma das soluções que pretendemos implementar no curto-prazo é um sistema de informação que registre todas estas operações e solicitações junto do cliente. Queremos quantificar o número de pedidos, o tipo de problemas e o tempo demorado para resolver o problema junto do cliente.

Por último, o nosso equipamento tem uma garantia de 30 dias, sujeito a devolução total dos custos suportados pelo cliente, caso o cliente não fique satisfeito.

13. Quais são os vossos principais clientes? Existem casos de estudo?

Temos vários clientes sobretudo na zona norte do país. Temos essencialmente clientes no sector industrial, que tem uma forte implementação nesta zona do país. Como exemplo posso citar o seguinte dois clientes:

- TorresTIR;
- LusoCargo;

Para além destes clientes, gostaria de realçar que ganhamos um concurso público para a implementação da solução de VoIP no Ministério do Trabalho e Segurança Social.

Por último, estamos envolvidos num grande projecto que vai trazer grandes benefícios para a empresa. Estamos a mudar de localização para a zona de Braga, mais concretamente no centro de negócios IDEIA Atlântico. Simultaneamente, fomos responsáveis pela implementação do sistema de comunicações VoIP deste edifício.

14. Quais são os meios usados pela empresa para divulgar os vossos produtos?

A nossa aposta passa pela publicação das nossas soluções na Internet. Nós temos um “link” patrocinado no Google, caso o utilizador faça uma pesquisa por “VoIP”. Sabemos que os nossos clientes usam essencialmente a Internet.

Para além disso, às vezes publicamos alguns artigos em revistas e temos a nossa “newsletter”.

Uma outra fonte de divulgação mais informal dos nossos produtos passa pelo “word-of-mouth”. Os nossos clientes têm ficado muito satisfeitos com a nossa solução de VoIP e são eles que muitas vezes divulgam os nossos produtos junto de parceiros e associações comerciais de que fazem parte.

2. Distinctive Competencies

Empresa: VipVoz

Competências Centrais	Validação		Comentários
	Sim	Não	
Personalização da solução			

Creation of Value with OS Software in the Telecommunications Field

Parcerias com fornecedores e distribuidores	Sim		Apenas com distribuidores e outras empresas de VoIP. A empresa possui uma pequena equipa de gestão de parceiros.
Parcerias com empresas desenvolvedoras de software		Não	
Parcerias com Telcos		Não	
Conhecimento profundo da área de negócio VoIP		Não	
Conhecimento profundo da área de tecnologias de rede e multimedia	Sim		
Reputação da marca		Não	
Recursos técnicos ao nível de segurança		Não	
Equipa interna de I&D		Não	
Construção de soluções independentes do sist. operativo do cliente		Não	
Qualificação da equipa técnica		Não	
Testes e avaliação do código		Não	
Aposta na optimização da solução desenvolvida			
Suporte técnico fornecido ao produto	Sim		Este suporte técnico é de boa qualidade, apesar de não estar quantificado. Contudo, podem surgir problemas quanto à sua gestão, caso o número de clientes e pedidos aumente significativamente.
Integração de várias soluções no domínio open source e comercial		Não	
Robustez da solução desenvolvida		Não	
Escalabilidade da solução		Não	
Uso de tecnologias inovadoras		Não	
Rede de contactos da empresa		Não	
Perfil e experiência dos seus colaboradores		Não	
Interface gráfica com o utilizador		Não	
Foco na usabilidade da solução		Não	

3. Other documents

Tarifário da VipVoz

Destino	Preço (euros)
PORTUGAL	0.017
PORTUGAL TELEMOVEL	0.230
ESPANHA	0.017

ESPAÑA NUMERO PESSOAL	0.450
ESPAÑA TELEMOVEL	0.234
ALEMANHA	0.017
ALEMANHA TELEMOVEL	0.250
ROMENIA	0.101
ROMENIA TELEMOVEL	0.236
RUSSIA	0.042
RUSSIA MOSCOVO	0.017
RUSSIA TELEMOVEL	0.041
BRASIL	0.044
BRASIL RIO	0.017
BRASIL TELEMOVEL	0.165
CUBA	0.832
ANGOLA	0.142
ANGOLA TELEMOVEL	0.227

Annex K – Bicom Systems Documents

1. Interview – Bicom Systems

Contact: Drº Stephen Wingfield (CEO and founder of Bicom Systems)

1. Why did Bicom Systems select the Asterisk platform to develop its own VoIP solution?

Asterisk provided the largest community and most features and functions. We had a turnkey CRM/CMS software and we felt many community members would benefit from a complete solution. This was four years ago when many said what we had done was not possible. Now many have copied.

2. Which are the strongest points of your VoIP solution comparing with others VoIP solutions available in the market?

Essentially the completeness and maturity of the solution. Besides that, it was the first Desktop Application (Glocom).

3. Is it possible to define a trade-off between the quality of the call and the price to pay? Explaining in other way, has your VoIP solution established some quality levels?

We do not provide origination/termination of calls.

4. What is the importance of the SERVERware solution for your company?

SERVERware provides self-healing redundant clusters, the base of our service provider solutions.

5. Does the VoIP solution developed at your company address the enterprise market or also the domestic market?

We have solutions for service providers ITSPs. They are responsible to serve residences. PBXware is also used increasingly in smarthome environments where a few hundred buildings are coming together.

6. Which are the most important marketing tools that your company uses to divulge your products/solutions?

We do not spend money on marketing. For us, our marketing approach includes the use of Internet marketing, mailing list, word of mouth and resellers.

2. Distinctive competencies

Empresa: Bicom Systems

Competências Centrais	Validação		Comentários
	Sim	Não	
Personalização da solução		Não	
Parcerias com fornecedores e distribuidores	Sim		
Parcerias com empresas desenvolvedoras de software			
Parcerias com Telcos	Sim		
Conhecimento profundo da área de negócio VoIP	Sim		

Conhecimento profundo da área de tecnologias de rede e multimedia	Sim		
Reputação da marca	Sim		
Recursos técnicos ao nível de segurança	Sim		Funcionalidades com especial ênfase no domínio da segurança na solução SERVERware.
Equipa interna de I&D		Não	
Construção de soluções independentes do sist. operativo do cliente		Não	
Qualificação da equipa técnica		Não	
Testes e avaliação do código			
Aposta na optimização da solução desenvolvida	Sim		Lançamento constante de novas funcionalidades e versões do PBXware.
Suporte técnico fornecido ao produto	Sim		Com 3 níveis de suporte mais contractos de manutenção
Integração de várias soluções no domínio open source e comercial	Sim		Integration with CRM and CSM solutions.
Robustez da solução desenvolvida	Sim		Através da solução SERVERware.
Escalabilidade da solução		Não	
Uso de tecnologias inovadoras		Não	
Rede de contactos da empresa	Sim		
Perfil e experiência dos seus colaboradores	Sim		
Interface gráfica com o utilizador		Não	
Foco na usabilidade da solução		Não	

3. Other documents

Technical Support and Maintenance Packages

Standard Features	Standard Support	Priority Support	Emergency Support	System Maintenance
Support Access Method(s)	Email	Email, Online Chat	Email, Online Chat and Phone	n/a
Email Ticketing	Unlimited	Unlimited	Unlimited	n/a
Online Chat	n/a	Unlimited	Unlimited	n/a
Phone Support	n/a	n/a	Unlimited	n/a
Response Time	24 Hours	4 Hours	1 Hour	n/a
Availability	24/7	Mon-Fri, 8am-5pm	24/7	n/a
Pricing	Standard Support	Priority Support	Emergency Support	System Maintenance

Standard Support

Standard Features

- Email Support Access Method(s);
- Unlimited Email Ticketing;
- 24 Hours Response Time;
- 24/7 Availability.

Support Access Method(s)

These are available access methods for obtaining support per support package.

Email Ticketing

Our web site customer online access allows easy management of all support tickets. Customer can search, view and sort the tickets by various statuses.

Response Time

We strive to respond to our customers issues as soon as possible. Response time for each package is stated above.

Availability

Each tech support package is available during st

Priority Support

Standard Features

- Email, Online Chat Support Access Method(s);
- Unlimited Email Ticketing;
- Unlimited Online Chat;
- 4 Hours Response Time;
- Mon-Fri, 8am-5pm Availability.

Support Access Method(s)

These are available access methods for obtaining support per support package.

Email Ticketing

Our web site customer online access allows easy management of all support tickets. Customer can search, view and sort the tickets by various statuses.

Online Chat

Online web based chat is service very much offering speedy resolution to your issues since the response is in most cases immediate.

Response Time

We strive to respond to our customers issues as soon as possible. Response time for each package is stated above.

Availability

Each tech support package is available during stated days/times.

Emergency Support

Standard Features

- Email, Online Chat and Phone Support Access Method(s);
- Unlimited Email Ticketing;
- Unlimited Online Chat;
- Unlimited Phone Support;
- 1 Hour Response Time;
- 24/7 Availability.

Support Access Method(s)

These are available access methods for obtaining support per support package.

Email Ticketing

Our web site customer online access allows easy management of all support tickets. Customer can search, view and sort the tickets by various statuses.

Online Chat

Online web based chat is service very much offering speedy resolution to your issues since the response is in most cases immediate.

Phone Support

Phone support is most appropriate for customers not having access to Internet.

Response Time

We strive to respond to our customers issues as soon as possible. Response time for each package is stated above.

Availability

Each tech support package is available during stated days/times.

Annex L – Critical Links Documents

1. Interview – Critical Links

Contact: Engº João Belo (Marketing Manager)

1. Como foi desenvolvido a edgeBox na vossa empresa? Existiu uma equipa técnica dedicada a 100%?

Este projecto teve a sua origem na empresa Critical Software. Na altura surgiu esta ideia de uma forma informal, tal como sucede com muitas outras, dentro da Critical Software. Na altura uma das nossas grandes fontes de inspiração foi o sistema operativo Linux, onde todo o conceito da edgeBox teve a sua origem. No início do projecto estavam alocadas cerca de 3 a 4 pessoas e ao longo deste projecto este número foi crescendo, à medida que a edgeBox ganhava forma e as funcionalidades da aplicação iam também aumentando.

Um dos marcos mais importantes foi o surgimento da Critical Links. Na altura, e depois de ficar definido o modelo de negócio, chegou-se à conclusão que seria positivo lançar-se uma spin-off designada por Critical Links que iria ficar dedicada em exclusivo ao desenvolvimento desta solução.

2. Qual é a plataforma open-source que serve de base à vossa solução? Qual a relação da Critical Links com este projecto base e possíveis contribuições?

Diria que a plataforma mais importante para nós foi sem dúvida o Linux. Inicialmente a versão da edgeBox era baseada na versão Debian do Linux, mas agora já não se pode afirmar isto. Para além do Linux, foram usadas outras plataformas de desenvolvimento, tanto open source como comerciais, sendo que uma das quais foi o Asterisk, que serve de base à construção dos nossos serviços na área do VoIP.

3. Quais foram os principais obstáculos encontrados?

O nosso principal obstáculo não esteve em termos técnicos, mas ao nível da construção do nosso modelo de negócios. Na Critical Software tínhamos experiência num modelo baseado exclusivamente em serviços, mas com a edgeBox seria necessário optar-se por um modelo diferente. Optou-se por desenvolver um modelo de negócio em que a venda da edgeBox é efectuada pelos parceiros da Critical Links.

Em termos técnicos a nossa principal dificuldade esteve ao nível da estabilidade do produto e da interface gráfica. A interface gráfica acabou por ser uma parte crítica na construção do nosso produto, pois foi através dela que conseguimos fazer alguma diferenciação. Inicialmente a interface gráfica foi desenvolvida em Java, mas actualmente esta interface já se encontra em HTML e Ajax.

4. A Critical Links possui alguma certificação de qualidade? Qual é a importância dessa certificação para a Critical Links?

Não temos certificação de qualidade, nem esta certificação acaba por ser muito importante para a nossa aplicação. O mais importante para nós é focar na qualidade do produto final, enquanto que o desenvolvimento do mesmo passa para plano secundário. Contudo, a nossa empresa mãe (Critical Software) tem certificação ISO e CMMI de nível 3, e brevemente irá passar a ser certificada como nível 5. Temos esta mais valia a oferecer aos nossos clientes. Porém, a aquisição de certificação CMMI por parte da Critical Links não se encontra nos nossos próximos planos, pois os custos da certificação são bastante elevados. Gostaria também de referir que a nossa metodologia de trabalho segue uma estrutura idêntica à da Critical Software, o que certamente nos facilitaria a aquisição de certificação. A sua não existência é devida unicamente a aspectos financeiros.

Por último, temos realmente apostado naquilo que para o cliente é importante. Os prémios ganhos em eventos e feiras internacionais dão-nos mais visibilidade e atestam a qualidade das nossas soluções.

5. Quais são as razões para a empresa apostar numa solução completa de gestão da rede em detrimento de uma maior ênfase no segmento do VoIP?

O VoIP é para nós uma componente importante da solução edgeBox, mas temos consciência que a nossa vantagem competitiva não se encontra neste ponto. A nossa vantagem competitiva reside no facto de conseguirmos oferecer toda a solução (all in-one) de uma aplicação de gestão da rede de comunicações de uma empresa. Nesta área de actuação fomos únicos em termos mundiais. Mais nenhuma empresa possui uma solução idêntica que enderece o mesmo mercado.

6. Qual o perfil dos vossos clientes da edgeBox? Segmento comercial e doméstico?

Nós apenas endereçamos o segmento comercial. O mercado doméstico não é atractivo para nós atendendo às funcionalidades disponibilizadas pela solução e ao seu preço.

Diria que o nosso cliente tipo é uma pequena e média empresa com uma dimensão aproximada de 30 a 60 colaboradores.

7. Quais são as mais valias da edgeBox, face a outras existentes no mercado empresarial?

A nossa grande mais valia encontram-se no seguinte dois níveis:

- Integração de funcionalidades;
- “User friendly” (configuração fácil).

8. Como é realizada a transferência de uma solução de gestão da rede e comunicação tradicional para a edgeBox?

Para nós os mercados “green-field” são os mais interessantes. Por este tipo de mercado entendemos empresas que não possuem soluções de gestão de rede já em funcionalidade.

Contudo, sabemos que muitos dos nossos clientes já têm soluções de redes nas suas empresas e preferem fazer uma integração gradual. Para estes clientes podemos activar gradualmente as funcionalidades que mais lhes convêm e utilizar as PBXs antigas da empresas, e ir passando gradualmente para uma solução de IP a 100%.

9. Como é feita a negociação do preço a pagar por cada chamada (nacional/internacional)?

Este preço é estabelecido por cada VoIP provider. A edgeBox não estabelece à partida este tipo de tarifário. Cabe portanto, ao cliente definir a lista de “providers” e “brokers” que pretende usar ao nível das suas comunicações VoIP.

10. É possível ao utilizador definir um “trade-off” entre o custo da chamada e a sua qualidade?

A edgeBox o que garante é uma prioridade do tráfego de voz face ao restante tráfego. Quanto à qualidade das chamadas esta é condicionada pelos brokers que são usadas e que foram definidos no passo anterior. Por si só, a edgeBox não garante este mecanismo de “trade-off” entre custo das chamadas e qualidade das mesmas.

11. Que tipo de parceiros possui a Critical Links?

Os parceiros para a Critical Links revelam-se de grande importância. Na Critical Links estabelecemos três tipos de parceiros:

- Operadores de telecomunicações;

- Pequenos revendedores da edgebox;
- Equipamento de rede OEM.

No total temos cerca de 30 parceiros, sendo que 50% deles são nacionais.

12. Que suporte técnico garante a empresa?

Os clientes da edgeBox têm sempre duas alternativas quanto ao suporte técnico. Uma é optar por ter este suporte técnico directamente junto dos revendedores onde adquiriram a edgeBox. A outra alternativa é optar por ter este mesmo suporte junto da Critical Links. A Critical Links garante um suporte de três níveis:

- 1ª linha – helpdesk tradicional;
- 2ª linha – atendimento por pessoal técnico;
- 3ª linha – diagnóstico remoto.

13. Quais são os vossos principais clientes? Existem casos de estudo?

Neste momento posso afirmar que os nossos principais clientes são a Portugal Telecom (PT) e a Etronics. Informação sobre outros clientes encontram-se disponíveis na nossa página web.

Relativamente aos casos de estudo, aqueles sobre os quais podemos disponibilizar informação também se encontram afixados na nossa página web.

14. Existem estatísticas do número de vendas por segmento de mercado ou segundo uma distribuição geográfica?

Sim. Internamente temos esta informação, mas não podemos torná-la pública.

Contudo, diria que os nossos principais mercados são a Europa central e os Estados Unidos da América (EUA). Estes dois mercados são seguramente os mais rentáveis. Aliás, estamos em processo de transferência da sede da empresa para os EUA.

15. Qual é a importância das soluções “edgePACKs” e “iTEMS” para a Critical Links?

A importância destas duas soluções no total de vendas da Critical Links é diminuta, não ultrapassando os 5 a 10%. O objectivo da edgePACKs é o de tentar garantir uma rentabilidade adicional junto de clientes que já possuem a nossa solução edgeBox original. O “iTEMS” é unicamente adquirido por clientes de maior dimensão e visa dotar a edgeBox de uma plataforma de gestão e controlo de várias edgeBox em simultâneo.

16. Quais são os meios usados pela empresa para divulgar os vossos produtos?

O marketing é para nós um instrumento de grande importância. Optamos por ter uma presença na web e também uma presença nos media internacionais, através das “press-releases” que são publicados em revistas de referência no panorama internacional das tecnologias da informação. Para além disto, estamos presentes nos eventos de maior dimensão a nível mundial na área das telecomunicações e sistemas de informação.

Por último, efectuamos também campanhas de promoção junto dos nossos revendedores e dos clientes finais. O folheto da Critical Software segue por via electrónica e por correio tradicional para os nossos parceiros e clientes alvo. Para além disso, contamos com a máquina de marketing dos nossos parceiros na divulgação das nossas soluções.

2. Distintive competencies

Empresa: Critical Links

Competências Centrais	Validação		Comentários
	Sim	Não	
Personalização da solução	Sim		Mas bastante limitado, de acordo com a gama de funcionalidades disponibilizada pela edgeBox.
Parcerias com fornecedores e distribuidores	Sim		
Parcerias com empresas desenvolvedoras de software		Não	
Parcerias com Telcos	Sim		
Conhecimento profundo da área de negócio VoIP			
Conhecimento profundo da área de tecnologias de rede e multimédia	Sim		
Reputação da marca	Sim		Trata-se de uma das principais empresas tecnológicas a nível nacional e um dos produtos mais divulgados.
Recursos técnicos ao nível de segurança	Sim		Integrados numa solução de conjunto e com acesso centralizado.
Equipa interna de I&D	Sim		Uma aposta contínua da CSW e da Critical Links com uma aposta de 10 a 15% dos seus dividendos nesta área.
Construção de soluções independentes do sist. operativo do cliente	Sim		
Qualificação da equipa técnica	Sim		
Testes e avaliação do código	Sim		Baseado no mesmo procedimento de testes que garantiram a certificação CMMI.
Aposta na optimização da solução desenvolvida		Não	
Suporte técnico fornecido ao produto	Sim		Directamente pela Critical Links ou através de parceiros.
Integração de várias soluções no domínio open source e comercial	Sim		
Robustez da solução desenvolvida		Não	
Escalabilidade da solução		Não	
Uso de tecnologias inovadoras	Sim		
Rede de contactos da empresa	Sim		Nomeadamente através da sua rede de parceiros
Perfil e experiência dos seus colaboradores	Sim		Tanto do ponto de vista técnico como ao nível da área de negócio.
Interface gráfica com o utilizador	Sim		Nova interface em HTML e Ajax.
Foco na usabilidade da solução	Sim		

3. Other documents

edgeBOX technical sheet Software Features

VoIP and IP-PBX	Collaborative Services
SIP and IAX support	HTTP server with user home pages
Analogue and digital PSTN gateway	FTP server
Least Cost Routing	Email server supporting
Interactive Voice Response	Email remote storage
Automatic Call Distribution	Email antivirus
Telephone Number Mapping	Email antispam
Digital Receptionist	Print Server
Incoming Call Rules	Windows File Sharing
DID Call Routing	High Availability
Call Parking	Data backup to remote FTP site or USB pen
Call Forwarding	Automatic, configurable regular backups
Conference Bridging	Manual restore of backed up data from restore list
Hunt Groups	Failover and dual-homing
User profiles with call permissions	Security
IP Quality of Service (IP QoS)	Filter on source and destination IP address or port
DiffServ traffic prioritisation	Stateful inspection
Inbound and Outbound QoS	Provides enterprise-grade firewall protection
CBQ traffic prioritisation	Unlimited number of rules
Configurable traffic prioritisation policies	Group based access control
Networking	Virtual private networking
PPP over Ethernet and PPP over ATM	User authentication
Automatic IP and DNS assignment	Configuration and Management
Static Routing on the LAN and/or WAN	Wizard based setup
DHCP server and client	Syslog server support
Dynamic DNS Client	Local and remote management
Network Address Translation (NAT)	Software update management
Port Forwarding	Notifications for service shutdown and service restart for planned maintenance
Supports public web and e-mail servers with NAT	Anti-piracy protection

Hardware Features

WAN Interface	LAN Interface
Cable and ADSL modems	Primary Ethernet
UMTS	Secondary Ethernet for DMZ
Ethernet-based modems	WiFi AP mode
EWAN Interface	Serial Interface
Ethernet port for enterprise WAN	One asynchronous serial console port

List of international awards

Award	Year	Description
	2008	Critical Links Awarded "Best of Show" at INTERNET TELEPHONY® Conference & EXPO East 2008
	2007	Critical Links' Receives INTERNET TELEPHONY 2007 EXCELLENCE Award
	2007	Critical Links' edgeBOX Wins TechWorld's Prestigious "Convergence Product of The Year" Award edgeBOX Business Gateway Distinguished in Fiercely Competitive Category
	2007	Critical Links' edgeBOX Wins TMC LABS 2007 INNOVATION Award
	2006	Critical Links Receives INTERNET TELEPHONY® Magazine's 2006 Product of the Year Award Critical Links "All in One" Networking Device edgeBOX Recognized for Outstanding Innovation
	2006	Communications Solutions 2006 Product of the Year Award
	2005	edgeBOX wins the 2005 IEC InfoVision Award for the Best Broadband Appliance

Annex M – iPortalMais Documents

1. Interview – iPortalMais

Contact: Prof^o Dr^o Raúl Oliveira (CEO da iPortalMais)

1. Como foi desenvolvido o sistema IPBrick internamente na vossa empresa? Existiu uma equipa técnica dedicada a 100%? Qual foi a vossa metodologia de trabalho?

O projecto inicial lançado pelo iPortalMais foi a solução iPortalDoc. A solução iPortalDoc é baseada no sistema operacional Linux e este sistema acabava por ser bastante difícil de ser configurado, pois para além da aplicação era necessário que todo o sistema Linux estivesse bem configurado. E neste último aspecto encontrava-se o nosso principal problema.

Na altura, um dos nossos clientes sugeriu que o que pretendia era ter o sistema operacional Linux bem configurado na sua empresa, algo que não conseguiria fazer sozinho, ou seria necessário dispendir um grande volume de tempo. Assim, surgiu a ideia de criar o IPBrick, que ficaria responsável pela instalação e configuração de todos os aspectos ligados à comunicação e configuração do sistema operacional Linux.

Passado algum tempo estes dois projectos foram separados e cada um deles tem uma equipa de trabalho distinta. O objectivo é gerir estas duas soluções de forma independente, mas dentro da mesma empresa.

2. Qual é a plataforma que serve de base à vossa solução?

As nossas duas soluções estão baseadas e rodam sobre o sistema operacional Linux. O nosso sistema de comunicações tem por base essencialmente as seguintes ferramentas open source:

- OpenSER;
- Asterisk.

3. Quais foram os principais obstáculos encontrados no desenvolvimento e comercialização do IPBrick?

O aspecto da comercialização acabou por ser um dos aspectos mais simples para nós, uma vez que nunca tivemos que fazer uma procura exaustiva de clientes. Foram até os nossos clientes que sugeriram os nossos serviços e nós fomos de encontro às solicitações do mercado.

Para a nossa empresa, o que acabou por ser mais complicado de definir foi o modelo de crescimento que pretendíamos ter e o tipo de serviço de suporte e assistência que pretendemos fornecer aos nossos clientes.

4. Quais são as principais alterações que a vossa solução tem sofrido desde que se encontra no mercado?

No início as duas soluções iPortalDoc e IPBricks funcionavam em conjunto e o que fizemos foi separá-las. Criamos o IPBrick.IC que é responsável por toda a infraestrutura base de hardware e o IPBrick.GT que tem por missão criar serviços de comunicação integrados sobre uma plataforma IPBrick.IC.

Para além disso, criamos um serviço de recuperação de funcionamento do sistema e de reinstalação com as configurações default de um sistema Linux, que nos veio diminuir em muito o tempo dispendido com o suporte ao cliente.

5. A empresa endereça as suas soluções para o mercado empresarial ou residencial?

Neste momento só endereçamos o segmento empresarial, mas em breve vamos também entrar no segmento residencial. Para entrar no mercado residencial temos consciência que temos que definir um novo modelo de suporte ao cliente e de aumentar a usabilidade e a facilidade de configuração do sistema. Neste momento, o nosso processo de instalação já suporta um mecanismo de configuração orientado aos serviços das empresas e não aos serviços de tecnologia disponibilizados.

6. Quais são as mais valias das vossas soluções, nomeadamente na área de VoIP, face a outras existentes no mercado?

Nós não pretendemos oferecer aos nossos clientes unicamente um serviço de comunicação de voz baseado na tecnologia VoIP. Nós queremos ir mais além deste serviço, através da utilização de protocolos abertos e compatíveis entre si. O nosso objectivo é oferecer aos nossos clientes um serviço unificado de comunicações sobre IP, abrindo novas perspectivas para as comunicações empresariais, usando as diferentes formas de comunicar que a Internet oferece de uma forma integrada: voz, correio electrónico, fax, mensagens instantâneas, webchat e webphone.

Para além disso, o IPBrick é licenciado por servidor, o que facilita a nossa entrada em grandes clientes, uma vez que podemos oferecer custos de implementação mais baixos que os nossos concorrentes.

7. Como é feita a negociação do preço a pagar por cada chamada (nacional/internacional)?

O IPBrick não estabelece à partida quais são os “providers” e os operadores de telecomunicações que serão usados. Cabe aos nossos parceiros ou aos clientes definir esta situação.

8. É possível ao utilizador definir um “trade-off” entre o custo da chamada e a sua qualidade?

Esta funcionalidade ainda não se encontra implementada.

O que existe neste momento são rotas de “fault-back” caso uma ligação VoIP esteja em baixo ou com um elevado “delay”. Contudo, este mecanismo de fault-back só se encontra implementado entre rotas VoIP, uma vez que as rotas PSTN têm custos muito mais elevados.

9. Qual a razão de a empresa apostar também na área da gestão de conteúdos e documentação?

A nossa solução iPortalDoc foi o nosso primeiro produto e assumiu-se sempre como um produto inovador e rentável. Para além disso, a existência do IPBrick possibilitou ao iPortalDoc oferecer um conjunto de funcionalidades que não estavam originalmente disponíveis como a integração com o SugarCRM ou o registo de chamadas VoIP num sistema de gestão documental.

Por último, o iPortalDoc tem por base a oferta de serviços de consultoria que são mais caros que os produtos standard disponibilizados pela empresa e que permitem criar valor junto do cliente.

10. Qual é a importância relativa das diversas soluções disponibilizadas pela iPortalMais? A solução na área das comunicações é a mais importante?

Neste momento a nossa fonte de receita destas duas aplicações é quase igual, sendo que o IPBrick representa cerca de 60% do volume de negócios e o iPortalDoc cerca de 40%.

11. Que suporte técnico garante a empresa?

O suporte técnico pode ser oferecido directamente pela empresa ou através dos nossos parceiros. A iPortalMais oferece um suporte de 1ª, 2ª e 3ª linhas, através dos nossos revendedores, distribuidores e fabricantes. Este suporte técnico pode variar de acordo com a área geográfica dos nossos clientes.

12. Quais são os vossos principais clientes?

Os nossos principais clientes são:

- Ministério das Obras Públicas;
- ONI Telecom;
- Novis;
- Ministério da Economia;
- Mota Engil;
- Efacec;
- Fertágus;
- Câmara Municipal de Gaia.

13. Quais são os meios usados pela empresa para divulgar os vossos produtos?

O nosso site web é o nosso principal meio de comunicação com o cliente. Ao mesmo tempo, apostamos por divulgar as nossas soluções em revistas internacionais, realizamos algumas entrevistas junto de jornais e temos a nossa “mailling-list”.

Por último, devo dizer que o nosso principal esforço em termos de marketing se encontra junto dos nossos parceiros, que foram responsáveis por encontrar grande parte dos nossos clientes.

2. Distinctive competencies

Empresa: iPortalMais

Competências Centrais	Validação		Comentários
	Sim	Não	
Personalização da solução	Sim		Possível unicamente usar parte dos serviços sobre Linux e implementar outros serviços sobre este sistema operativo.
Parcerias com fornecedores e distribuidores	Sim		
Parcerias com empresas desenvolvedoras de software		Não	
Parcerias com Telcos	Sim		Nomeadamente com operadores VoIP.

Conhecimento profundo da área de negócio VoIP		Não	
Conhecimento profundo da área de tecnologias de rede e multimedia	Sim		Com base no sist. operativo Linux.
Reputação da marca	Sim		Especialmente no mercado nacional.
Recursos técnicos ao nível de segurança	Sim		Baseado na robustez das aplicações sobre Linux.
Equipa interna de I&D	Sim		Participação em actividades de I&D junto de vários projectos open source.
Construção de soluções independentes do sist. operativo do cliente		Não	
Qualificação da equipa técnica	Sim		
Testes e avaliação do código		Não	
Aposta na optimização da solução desenvolvida	Sim		
Suporte técnico fornecido ao produto	Sim		Através de parceiros e directamente pela empresa.
Integração de várias soluções no domínio open source e comercial		Não	
Robustez da solução desenvolvida	Sim		Sistema Linux e aplicação IPBrick extremamente tolerante a falhas com mecanismo de fault-back.
Escalabilidade da solução	Sim		
Uso de tecnologias inovadoras	Sim		
Rede de contactos da empresa	Sim		
Perfil e experiência dos seus colaboradores		Não	
Interface gráfica com o utilizador		Não	
Foco na usabilidade da solução	Sim		Facilidade de instalação e configuração de serviços sobre Linux.

3. Other documents

Major Clients of iPortalDoc

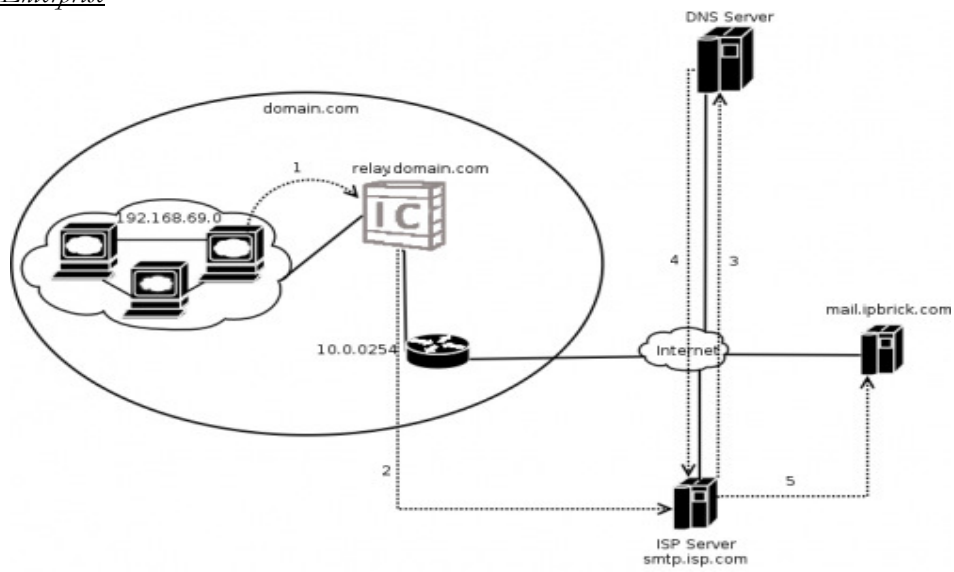
Algardata, Sistemas Informáticos	Energaia	NetDouro
Academia Postal (Espanha)	Euronavy	Netponto - Tecnologias Biométricas
ADREDV - Agência de Desenvolvimento Regional de entre Douro e Vouga	Fundação Minerva	Onsite
Águas de Trás-os-Montes e Alto Douro	Governo Civil do Porto	ORCIM
Águas do Douro e Paiva	Hospital Geral de Santo António	Ordem dos Arquitectos
Aldeia Digital (25 Juntas de	iPortalMais	People's Conseil Tecnologias de

Creation of Value with OS Software in the Telecommunications Field

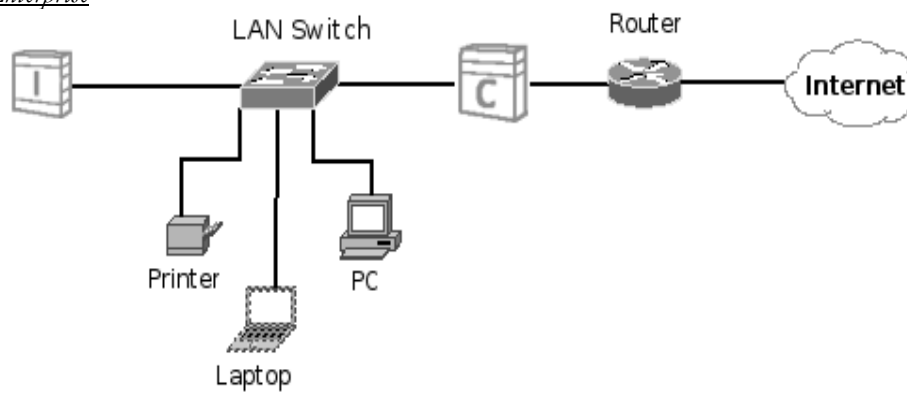
Freguesia de Barcelos)		Informação
APCOR - Associação Portuguesa de Cortiça	Junta Freguesia de Nevogilde	PMETPartner
AVP(SEA) (Malásia)	Lameirinho	Presild (Angola)
Brandkey - Serviços de Marketing SA	Lanidor	Remax Balaídos (Espanha)
Câmara Municipal de Santo Tirso	Lhyp (Espanha)	Rodonorte
CFPIC - Centro de Formação da Indústria de Calçado	Lisconcebe	SICLAVE
CITEX - Centro Formação Profissional Indústria Têxtil	Madeira Tecnopolo	SISCAD
DVHTecnopor	Madeira Wine Company	SoftMaker
EFACEC	MegaFlop	TorresTir
Electrosat (França)	NESI	Viaponte Projectos e Consultoria de Engenharia SA

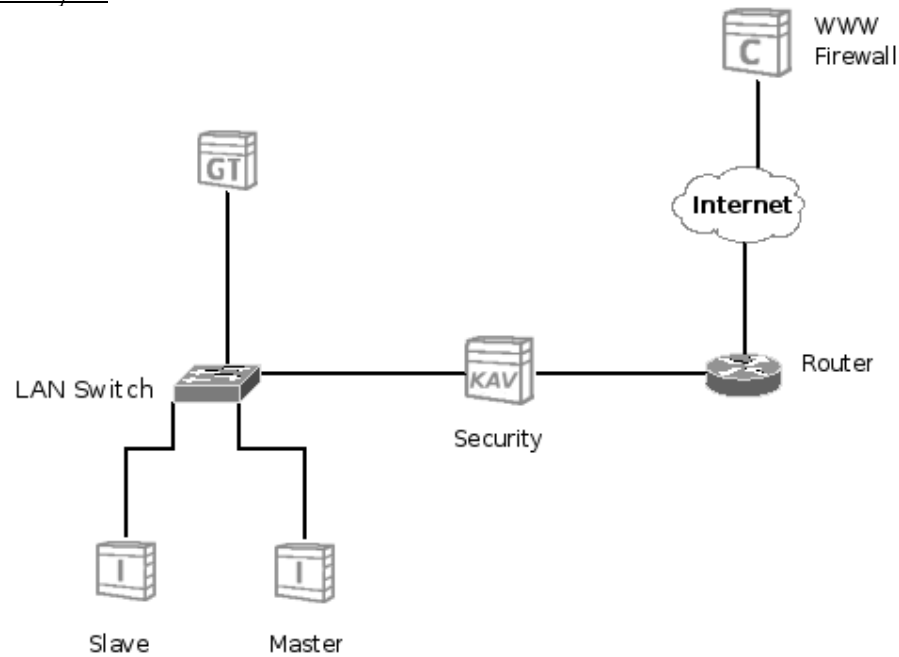
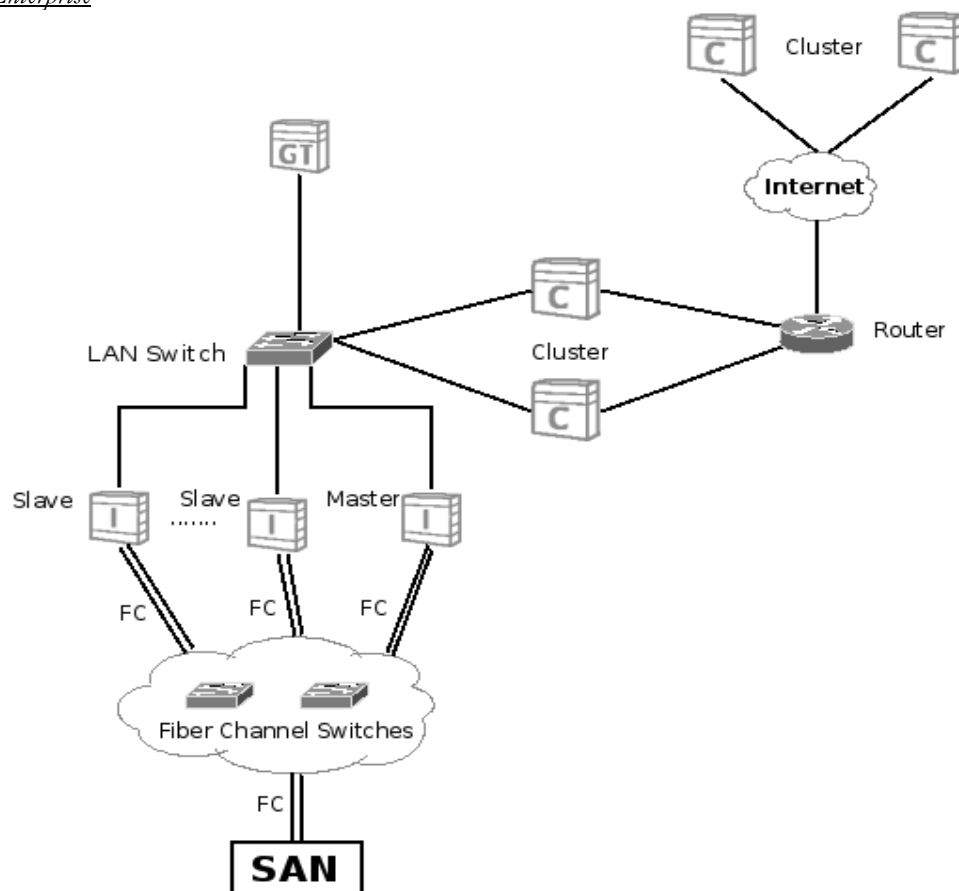
Typical solution of IPBrick.GT for companies

Micro Enterprise



Small Enterprise



Medium EnterpriseBig Enterprise

Annex N – VoIP@FEUP Documents

1. Interview – VOIP@FEUP (PolySpeak)

Contact: Engº João Carvalho (Project Manager)

1. O CICA realizou algum estudo prévio sobre várias soluções VOIP, no domínio comercial e Open Source, antes de implementar a sua solução?

Trata-se de um estudo realizado há cerca de 3 anos atrás. Na altura procurou-se no domínio comercial uma solução que servisse os requisitos da FEUP. Na altura, encontraram-se várias soluções interessantes, nomeadamente a da CISCO, mas os seus preços eram proibitivos para a FEUP.

Assim, optou-se por se realizar um estudo semelhante no domínio das soluções open source e verificou-se que existiam algumas soluções com algum potencial, mas que exigiam um trabalho de desenvolvimento por parte da equipa do CICA, até que estas soluções pudessem estar em “produção” na FEUP.

Esta última opção foi a solução adoptada.

Na altura foi elaborado um relatório em que se estudou comparativamente estas soluções, mas infelizmente este relatório já não se encontra acessível.

2. Que ferramentas Open Source servem de base à solução PolySpeak?

Na altura, optou-se por se usar as bibliotecas do Asterisk e fazer desenvolvimento interno com vista a implementar funcionalidades que não se encontravam disponíveis. Este conjunto de funcionalidades foi definido pela equipa técnica do CICA e pelo seu director, tendo com base o conjunto de funcionalidades disponíveis em soluções comerciais e os requisitos da comunidade académica da FEUP.

3. Qual é a arquitectura do PolySpeak? Existe algum diagrama?

A arquitectura do PolySpeak tem como base o Asterisk e as suas APIs. Estas APIs foram usadas para fazer o desenvolvimento de funcionalidades avançadas, tais como:

- 3 níveis de acesso e configuração do sistema;
- Controlo de custos por chamada;
- “Plafond” do custo de chamada por utilizador;
- Visualização do custo por utilizador e departamento;
- Selecção automática da rota mais económica.

4. Como são realizados os testes e a avaliação ao código desenvolvido?

Os testes a todo o código desenvolvido são realizados pela equipa técnica do CICA. As novas funcionalidades entram usualmente em produção depois de 2 semanas de testes. Estes testes podem ser realizados por toda a comunidade da FEUP, mas normalmente a maior contribuição advém dos próprios utilizadores do CICA.

5. O CICA possui alguma certificação de qualidade ao nível dos processos de desenvolvimento internos (ISO/CMMI)?

Não tenho conhecimento desta situação, mas é algo que normalmente não passa por mim. O Polyspeak não possui qualquer tipo de certificação, mas não sei se não existe alguma certificação deste tipo por parte do CICA. Para obter mais informações, aconselho que contacte o Engº Tito Vieira ou o Engº Manuel Machado.

6. Como funciona o sistema de “Call Box”? Como funciona o mecanismo de integração com o “livro de endereços”?

O utilizador via web pode procurar esta informação usando o web browser. Para tal, bastará inserir o nome do utilizador ou o número de telefone desse mesmo utilizador. Para além disso, via web é possível inserir este contacto directamente no telefone, sem ter necessidade de a inserir manualmente no telefone VoIP.

7. Como é implementado o sistema de lista de espera de chamadas?

O sistema de lista de espera de chamadas não foi implementado com recurso a software, mas usando as potencialidades dos telefones VoIP. Os telefones VoIP usados na FEUP, já possuem um sistema de identificação e gestão de chamadas em filas de espera, podendo o utilizador falar com várias pessoas simultaneamente. Esta gestão é realizada pelo seu próprio telefone VoIP. É o próprio telefone VoIP que limita o número de chamadas em simultâneo. No caso do telefone VoIP usado no CICA, o limite imposto é de 8 chamadas simultâneas.

Para além disso, foi desenvolvida uma funcionalidade de grande interesse para a comunidade FEUP. Neste caso, esta funcionalidade é implementada com recurso a software. Cada utilizador pode definir uma lista “branca” e “negra” de contactos, atendendo só chamadas cuja origem é “branca” no caso de se encontrar ocupado. Todas as chamadas provenientes de contactos da lista “negra” são rejeitadas.

8. Como é estabelecido o custo de cada chamada?

O custo de cada chamada foi negociado pela FEUP com os operadores VoIP que apresentavam as melhores condições em termos de custo e qualidade de serviço. Para tal foi estabelecido uma “definition list” e “definition file” com os vários “trunks” disponibilizados por cada provider. Para além disso, a FEUP tem também acesso à informação dos “trunks” disponibilizados pela PT Comunicações.

Por último, o custo de cada chamada vai depender da qualidade definida pelo utilizador, tendo por base a aplicação do algoritmo LSR.

9. Como é negociado o custo de cada chamada (nacional e internacional)?

Cada entidade, no qual se encontra presente a FEUP, negocia os preços por “brokers”. Para cada broker, o custo pode ser diferente dependendo da qualidade de serviço que lhe encontra associado.

Por exemplo, numa chamada internacional de qualidade baixa para Espanha, pode ser usada uma ligação de Portugal-USA-Hong Kong-United Kingdom-Spain. Apesar de esta ligação ser

mais longa do que uma directa Portugal-Spain, pode apresentar custos sensivelmente mais baixos.

10. Há relação entre custo das chamadas e a sua qualidade? É possível ao utilizador estabelecer este “trade-off”?

Sim. Neste momento esta funcionalidade já se encontra implementada. O sistema permite definir três tipos de qualidade de serviço: low, normal, high. Para além disto, existe mais um nível de qualidade designado por “fax” que apesar de se encontrar previsto ainda não se encontra implementado.

11. Qual a taxa de adesão deste serviço na FEUP? Existem estatísticas e um historial por anos?

Neste momento existem 588 utilizadores registados no sistema e cerca de 289 telefones VoIP. Por email envio-lhe mais dados com esta informação.

12. A solução PolySpeak é usada por outras instituições de ensino, nomeadamente ao nível da Universidade do Porto (UP)?

Sim. Neste momento esta solução é também usada pela Faculdade de Nutrição e encontram-se em fase de negociações para serem usadas por outras instituições de ensino, particularmente no sector privado.

Para além disso, quando se efectua chamadas com outras entidades que usam a mesma solução Polyspeak, estas chamadas não são taxáveis recorrendo ao mecanismo ENUM, que contém a árvore internacional de mapeamento de números telefónicos para nomes de domínio.

13. Existem clientes no sector privado que também usam esta solução ou pretendam usá-la?

Sim. Esta solução já é usada por algumas entidades no sector privado, existindo um grande interesse por parte de outras entidades do sector privado que nos têm contactado nestes últimos meses.

Neste momento, a Casa da Música e a CCDDR-N já usam esta solução com grande sucesso.

Uma das questões que temos em aberto nesta altura é quanto à melhor solução em termos organizacionais para providenciar esta solução para outras entidades. Queremos divulgar a nossa solução e queremos tirar dividendo deste facto, mas ainda não temos uma estrutura organizacional definida que nos permita encarar com tranquilidade esta abertura ao exterior.

14. Que suporte técnico garante o CICA internamente? E perante clientes externos?

Internamente o CICA dispõe de um sistema de “helpdesk” que regista e apoia o utilizador caso tenha alguma questão. Este serviço é acessível a partir do sistema de “trouble tickets” via web ou telefonicamente para os nossos serviços.

Quando esta solução é usada por uma entidade externa, então, aquando do processo de negociação e instalação, existe um conjunto de sessões de formação junto da empresa cliente. Com estas sessões de formação iniciais pretende-se evitar que questões surjam na empresa

cliente sejam resolvidas por nós, mas devem ser solucionadas pela sua equipa técnica interna. Só em último recurso é que fomos chamados para resolver possíveis problemas.

2. Distinctive competencies

Empresa: VOIP@FEUP

Competências Centrais	Validação		Comentários
	Sim	Não	
Personalização da solução	Sim		Sobretudo ao nível da componente de integração web.
Parcerias com fornecedores e distribuidores		Não	
Parcerias com empresas desenvolvedoras de software		Não	
Parcerias com Telcos		Não	
Conhecimento profundo da área de negócio VoIP		Não	
Conhecimento profundo da área de tecnologias de rede e multimedia	Sim		
Reputação da marca		Não	
Recursos técnicos ao nível de segurança		Não	
Equipa interna de I&D	Sim		Aposta na presença em seminários e congressos internacionais.
Construção de soluções independentes do sist. operativo do cliente	Sim		
Qualificação da equipa técnica	Sim		Com elevada competência, sobretudo oriundos da FEUP.
Testes e avaliação do código			
Aposta na optimização da solução desenvolvida	Sim		
Suporte técnico fornecido ao produto		Não	
Integração de várias soluções no domínio open source e comercial		Não	
Robustez da solução desenvolvida		Não	
Escalabilidade da solução	Sim		
Uso de tecnologias inovadoras	Sim		
Rede de contactos da empresa		Não	
Perfil e experiência dos seus colaboradores		Não	
Interface gráfica com o utilizador	Sim		Interface gráfica que foi validada por uma equipa interna do CICA e pelos utilizadores.
Foco na usabilidade da solução	Sim		

3. Others documents

Tarifário (em cêntimos)

Portugal (rede fixa)	(*)
Vodafone (FEUP)	0
Vodafone	9
TMN	9
Optimus	9
Europa	2
EUA	2
América do Norte	2
América do Sul	5

(*) Depende do nível de qualidade (L, N, H) que for definido e pode variar de 1 cênt/min a 1,32 cênt/min.

- Todas as chamadas são taxadas em períodos de 60 segundos (ao minuto);
- As chamadas SIP/Enum não são cobradas aos utilizadores

Free Calls for Institutions based in Enum

Instituição	Números	PolySpeak?	ISN
Casa da Música	2201202XX	Sim	668
FCNAUP	22507432X	Sim	662
	2254339XX		
	22543910X		
	22543911X		
CCDR-N	22606149X	Sim	663
	2260742XX		
	2260863XX		
	226090713		
Reitoria (UP)	220408000 a 220408899	Não	-
IST (UTL)	218417000 a 21841999	Não	-

Annex O – Software Freedom Law Center

The Software Freedom Law Center (SFLC) provides legal services to the Free and Open Source Software (FOSS) community in five primary areas:

- Asset Stewardship;
- Licensing;
- License Defense and Litigation Support;
- Non-profit Corporate Assistance;
- Legal Consulting and Lawyer Training.

1. Asset stewardship

To ensure success, individual FOSS projects need more than a well-chosen license. The processes by which FOSS is produced must ensure that the rights of the FOSS community are preserved and promoted and avoid third-party intellectual property claims, which – as the SCO controversy has shown – have striking potential to disrupt enterprise adoption of FOSS. By bringing to bear the world’s leading expertise in the area, the SFLC offers a broad range of assistance for FOSS developers, ranging from disseminating general best practices guidance to crafting custom solutions for individual clients. This assistance establishes sound organizational and legal structures so that FOSS projects can be assembled and distributed in a way that protects the public’s right to access, use, and develop the software. The SFLC directly represents many of the most significant existing FOSS conservancies, and provides formation assistance for new projects seeking to create similar conservancies.

2. Licensing

The SFLC is directly involved in its clients’ FOSS license development efforts, including development of the [GNU General Public License v3](#) by the [Free Software Foundation](#), and offers licensing assistance, particularly license development and implementation consulting, to FOSS developers other than its clients. The SFLC also does community-wide licensing review and licensing analysis, for the purpose of identifying and addressing the causes of unnecessary FOSS license proliferation.

3. License defense and litigation support

The SFLC defends the integrity of FOSS licenses against both adverse judicial interpretation and legislative interference. The SFLC accepts primary responsibility for enforcement of US copyrights on the software of the represented asset stewardships, and coordinates international copyright enforcement efforts for such works as necessary. The SFLC also

assists clients and the general FOSS community in resolution of disputes relating to the use and development of FOSS.

4. Non-profit corporate assistance

The SFLC helps FOSS projects develop and maintain legal status to help ensure their longevity. The SFLC assists its clients with all stages of corporate existence, including formation and tax exemption, and helps projects with their contracts and governance. The SFLC established and continues to serve as counsel to the [Software Freedom Conservancy](#), which provides an alternative to independent corporate formation for FOSS projects. The SFLC is also able to represent its clients in negotiations.

5. Legal consulting and lawyer training

The SFLC provides enhanced long-term legal stability to the FOSS community by offering consulting to the public and training to attorneys involved with or interested in FOSS legal issues.

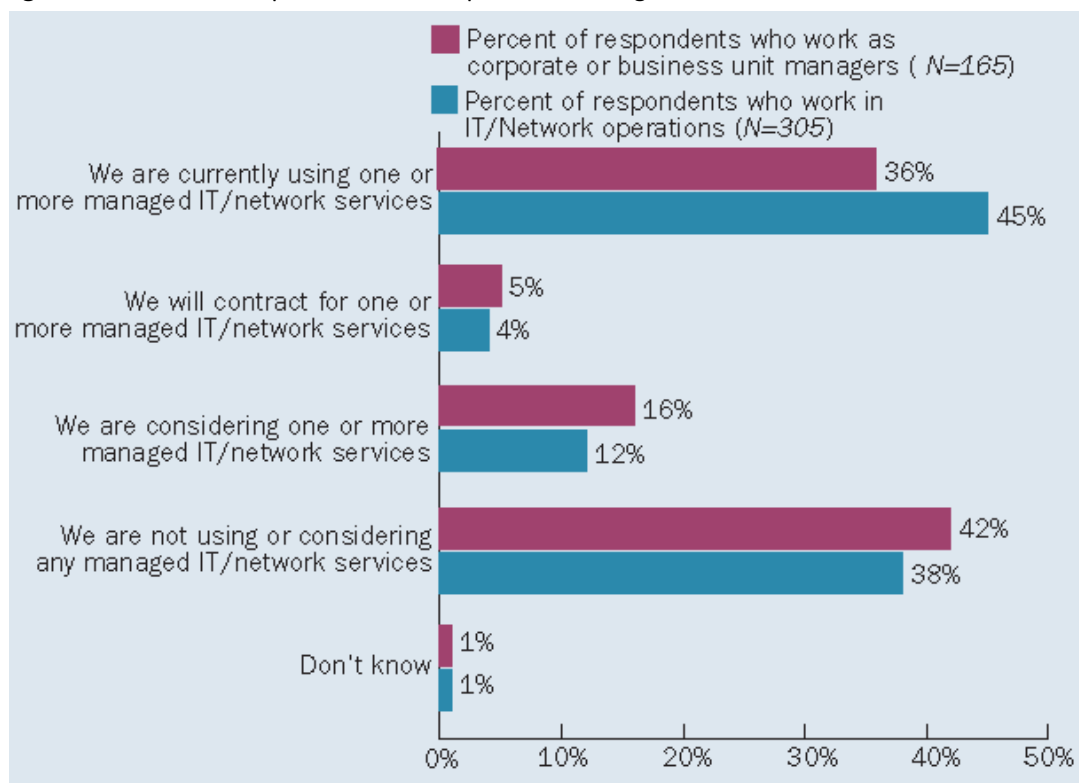
The SFLC gives seminars and makes public presentations from time to time on topics relating to FOSS software legal issues. The SFLC also welcomes requests for it to make presentations or give seminars on specific topics of interest. In the past, the SFLC has given presentations ranging from "An introduction to Free and Open Source Software Legal Issues" to "Patents and Free and Open Source Software" to "Version 3 of the GNU General Public License (GPLv3)" to many other topics relating to FOSS.

Annex P – ThinkStrategies.com Study

Another pertinent question about the use of IT managed services is to know if corporate and business unit managers are really more receptive than IT/network staff to use this kind of services.

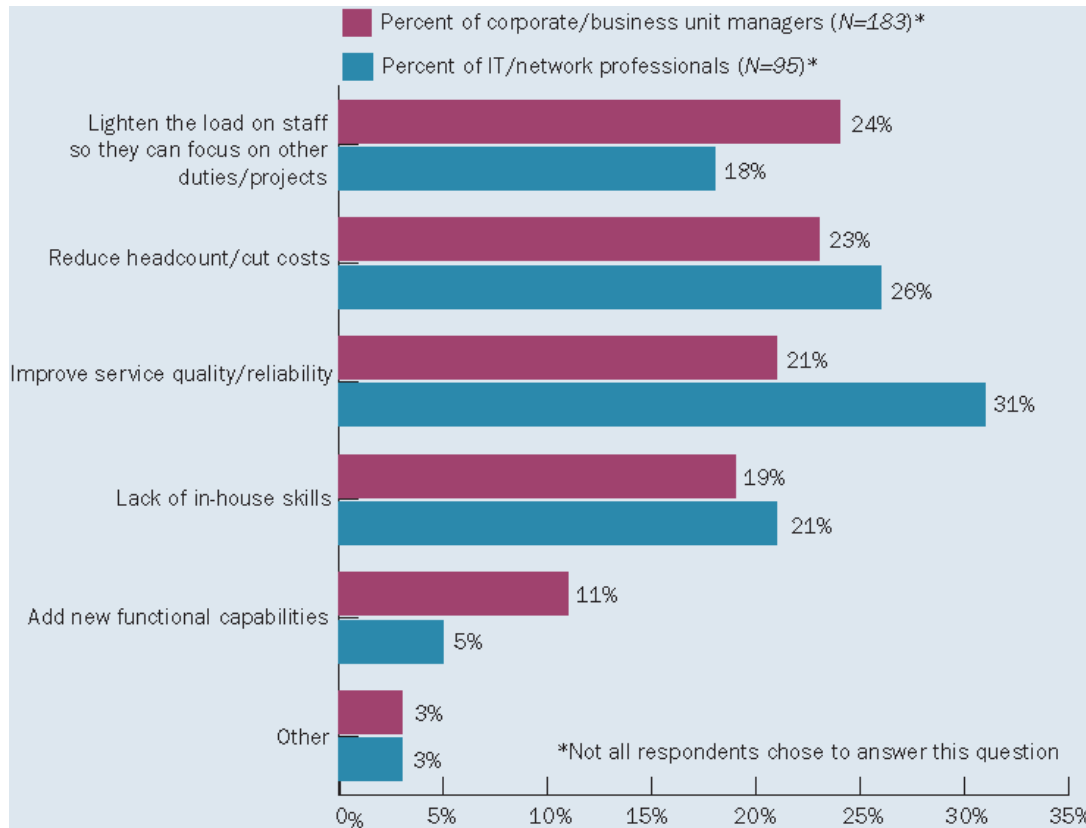
In figure P.1, for example, respondents who work in IT/network operations are more likely to already be using managed services than their colleagues who work in corporate management or in business units. Looking ahead, however, respondents from the business side are both more likely to be contracting for or considering managed services, and more likely not to be using or considering them. In order for MSPs to gain greater market penetration, especially among business unit decision-makers, they need to better understand the issues that are driving adoption. For instance, conventional wisdom holds that business-side managers are likely to be more receptive to managed services because they are seeking to reduce costs and increase performance, while IT/network staff is seeking to lighten their load and augment their skills.

Figure P.1: Different respondents' use or plans for managed services



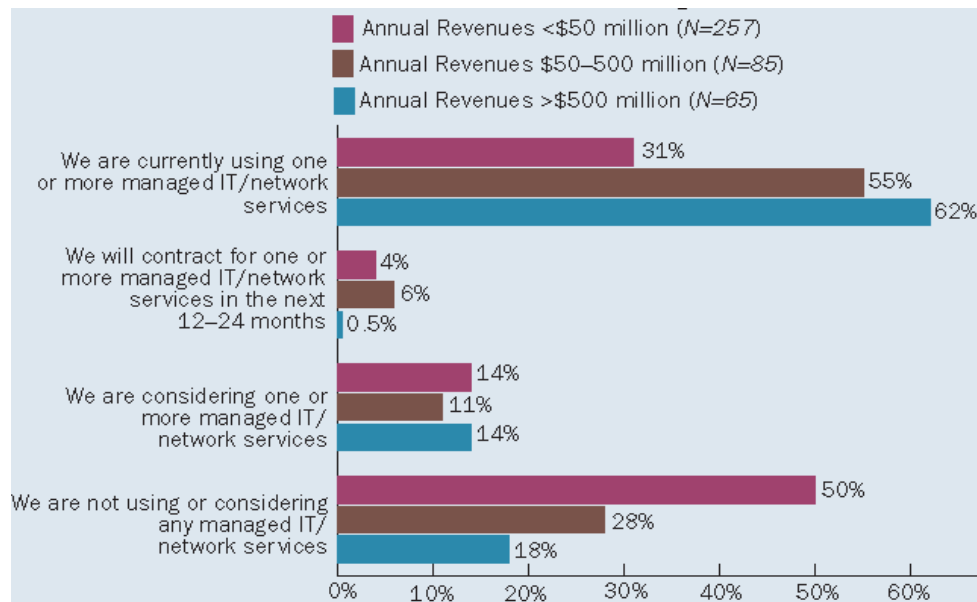
Source: Kaplan, 2006

Instead, as shown in figure P.2, we found that business unit respondents are almost equally driven by cost cutting (23 percent), service improvement (21 percent) and relieving staff to perform other tasks (24 percent). In contrast, nearly a third of IT respondents are looking for service improvements (31 percent), ahead of cost cutting (26 percent) and replacing missing skills (21 percent).

Figure P.2: Which are the primary reasons to use or consider managed services

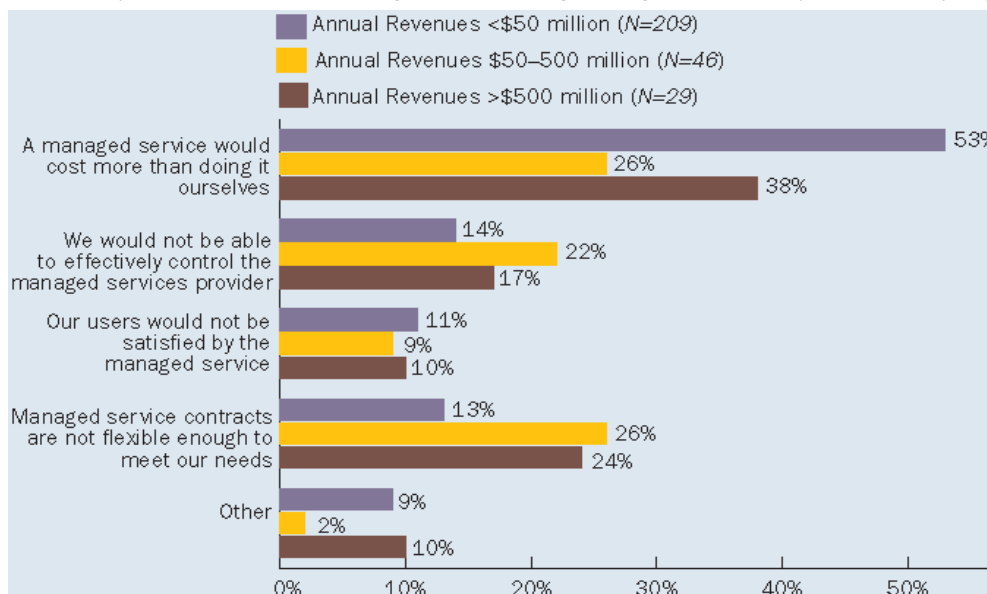
Source: Kaplan, 2006

Another common misconception on the part of some managed services providers is that their services appeal primarily to small and mid-size businesses rather than larger enterprises. The survey results clearly show that large enterprises are actually twice as likely as small organizations to already be using managed services, and equally likely to be considering them (figure P.3).

Figure P.3: What are the current plans for managed services

Source: Kaplan, 2006

Figure P.4 shows that more than half (53 percent) of the small organizations surveyed are not using or considering managed services because they believe these services will cost more than performing the same functions in-house. Larger enterprises are most likely to be avoiding managed services for cost reasons also, but they are also more concerned than the small organizations about managed service contract flexibility.

Figure P.4: Why customers are not using or considering managed services by size of company

Source: Kaplan, 2006

Annex Q – Major Open Source VoIP Applications

1. SIP proxies

SIP Proxies enable service providers to build scalable and reliable VoIP networks that are based on the Session Initiation Protocol. This allows a full array of call routing capabilities that make the most of network performance. Here are some of the most popular and successful SIP proxies on the market.

Application	Description
OpenSER	OpenSER has been described as a “mature and flexible” SIP server so it’s no surprise that it’s popular among users. OpenSER development began with FhG FOKUS SIP Express Router, but then diverged into its own feature-laden software package that was released in 2005. Since then it’s been exhibited around the world, and makes a great addition to Linux systems looking to employ VoIP technology.
VOCAL	Open source VoIP developers can benefit from the software and tools found in VOCAL. Developed through the Cisco sponsored labs at Vovida, VOCAL is fully customizable to business needs and can provide call routing, billing information, call control and more in an easy to control and maintain Linux based system. It’s been successful due largely in part to its immense capability for adaptation and scalability, and likely will only see further integration into business systems in the future.
partySIP	Developed back when VoIP was just starting to take off, partySIP can still be a relevant solution for businesses looking for VoIP today. This lies largely in the modular construction of partySIP, which relies on various plugins to add or remove capabilities. This flexibility allows its users to disable useless functions and enable new ones with very little development, making it easy to use and customize, which is likely the reason for users’ continued interest in the product.
SIP Express Router	This high performance SIP product can act as registrar, proxy or redirect server depending on your needs. It’s been widely successful in the VoIP market due to its ability to deal easily with operational problems like broken network components. Another reason it’s loved is its scalability from small office environments to acting as a PBX replacement and can in many cases act as a replacement for the very popular Asterisk system.
Mj Server	One of the things that makes MjServer so important to the VoIP market is that it works on a variety of platforms, not just Linux, so those who aren’t quite ready to take the fully fledged open source route can ease into it. MjServer is a Java based application that is easily configurable and can act as a registrar, redirect or proxy in your VoIP setup, making it a versatile and useful tool for implementation.
Open SBC	OpenSBC has been in use for over 7 years in both low and high volume applications. In this way, it’s a very reliable system, but also still employs a great deal of possibility for expansion and modification based on personal needs for the program. In fact, like most open source VoIP applications, the developers actively encourage the changing and development of the program to make it better for all users.
sipX	Developed by SIPFoundry, sipX is designed to be an incredibly feature rich and standards compliant infrastructure for businesses who want to employ VoIP technology. It is, in fact, one of the most widely used and well respected open source developments out there and feature wise is very similar to Asterisk.

Source: <http://www.virtualhosting.com/>, 2008

2. SIP clients

Session Initiation Protocol is a signaling protocol for Internet conferencing, telephony, presence, events notification and instant messaging, and is fast becoming one of the more popular protocols for VoIP in businesses and homes alike. Here are a few programs that have helped bring SIP to the forefront of the market.

Application	Description
Linphone	Linphone is promoted as a solution to help users communicate more freely over the Internet using voice, video and text messaging. Recent updates to the program have made it even better, solving many compilation issues while adding improved interoperability and new features. While currently only stable on Linux systems, development is under way for a Windows version as well.
PhoneGaim	If you haven't heard of PhoneGaim you've likely heard of its proprietary counterpart Gizmo Project. While it doesn't have the instant name recognition of its VoIP cousin Gizmo, PhoneGaim is still a product to take note of. Developed in an attempt to challenge Skype, the program is loaded with integrated features that help make the VoIP experience rewarding, even for those just using the software at home.
OpenWengo	Started and developed by the French company, Wengo, OpenWengo is a great, and popular, open source choice for anyone looking for simple and easy-to-use VoIP software. This softphone program allows users to call between computers and phones, and has additional instant messaging and contact management capabilities. The recent development of a Firefox plugin that allows users to make calls quickly and simply from their browsers is just one example of the continued innovation and popularity of this multi-featured program.
Cockatoo	Users of Thunderbird have Cockatoo to thank for simple VoIP integration with their email. The program allows users to make a call simply by clicking on entries in their address book. It's simplicity and aim to make VoIP more fully integrated into business systems has made it a popular addition to business and personal computers.
Minisip	Minisip is an Internet based phone that can be used to make phone calls, instant message and video call to anyone connected to the same SIP network. Developed by PhD and masters students at Royal Institute of Technology in Stockholm, Minisip is a simple but highly functional VoIP phone. Users can even make calls from PDAs or pocket PCs running Windows or Linux, making VoIP on the road easy and cheap.
OpenZoep	Developed by Voipster, OpenZoep is a popular client-side VoIP choice, providing the ability to both make calls and send and receive instant messages. Since its release, developers have continually added new features, especially from users in Europe, where the product was first developed. Continued changes and a responsive market have made OpenZoep a popular solution both here and abroad.
Shtoom	Shtoom is a open-source, cross-platform VoIP softphone, implemented in Python which also includes an application called doug which can be used to write and modify VoIP applications. This built-in framework for modification encourages customization, one of the reasons open source software is so popular.
Twinkle	Linux users have embraced the softphone Twinkle for making VoIP calls through an SIP protocol. Twinkle is a great solution for many users as it provides many, if not more, of the features found in regular telephony including custom ring tones, voice mail, conference calling, and multiple lines. These features, in addition to its open source usability, make Twinkle a popular choice among Linux users.

YeaPhone	YeaPhone is unique among open source VoIP systems in that it hopes to take the computer monitor and keyboard completely out of the picture when making VoIP calls. This makes it more similar to many commercially available phone systems, and a popular choice among users searching for an open source alternative to those systems.

Source: <http://www.virtualhosting.com/>, 2008

3. PBX platforms

PBX, or private branch exchange refers to the telephone operating systems of a business or office, rather than those established for public use. Part of those systems might include Interactive Voice Response, which allows the computer to detect voice and touch tones to route phone calls to the appropriate menus or locations. These VoIP programs have taken the lead in those technologies.

Application	Description
Asterisk	Asterisk is perhaps the greatest open source VoIP success story of them all. It is the leading open source telephony engine and tool kit and is used in thousands of servers and VoIP setups all over the world. What makes it so great? The standard system supports many features available in proprietary PBX system like voice mail, conference calling, interactive voice response, and automatic call distribution but also has the versatility to be adapted and personalized based on business or individual needs.
OpenPBX	Developed by Australian company Voicetronix, OpenPBX is a popular solution both with small offices and with large call centers. With features like unlimited voicemail, auto-attendant, automatic call distribution, music on hold and call parking it's easy to see why. It also has the advantage of highly compact Perl code, meaning it's very easy to customize and extend.
GNU Bayonne	An integral part of GNU telephony, Bayonne offers users technology that is not only free but scalable and customizable as well. Working with the complete suite of GNU enterprise solutions, Bayonne can be an easy way for users to integrate with telephony and provides a great VoIP solution for many.
CT Server	CT Server is based on the ccscrip language developed by David Sugar for the IVR server Bayonne as well as Perl for other tasks like database lookup. CT Server has been great resource for developers looking for framework for customizing or creating their own PBX quickly and creatively.
sipX PBX	One of the main competitors to Asterisk, the sipX PBX and Asterisk are often compared. In contrast with Asterisk's complete open source approach, sipX has a bit more of a commercial flair, as additional support and plugins can be purchased from the developers website. But sipX, once installed on your system, can provide much of the same functionality and in some cases might even be easier to use.
Trixbox	Fast becoming one of the most popular Asterisk based PBX phone systems, Trixbox has seen loads of success in the past few years from businesses and enterprises searching for a VoIP solution. Designed for businesses with anywhere from 2 to 500 employees, the product comes in a few different versions.
Evolution PBX	Evolution is another, more commercial application based on the open source server Asterisk. Basic editions of the software are free, however, and can be downloaded from the developers site. Evolution has been instrumental in helping solve one of the major obstacles to many businesses implementing VoIP as it makes integrating existing phone systems with newer VoIP systems easier, making the change much more cost effective for businesses, a key selling point for any VoIP product.

CallWeaver	Originally derived from Asterisk, CallWeaver works on many different platforms and with new versions being released regularly it has a growing list of features. CallWeaver was developed as an alternative form of Asterisk that encourages community involvement and employs multiple vendors who drive the project rather than just one working for a single interest. This open-minded approach to open source VoIP has won the program many fans who believe that it's already better than other versions of Asterisk.

Source: <http://www.virtualhosting.com/>, 2008

4. Stacks and libraries

Stacks and libraries are an integral part of what makes open source such powerful technology. Using these resources, businesses or individuals can develop and refine VoIP systems that work best for their business. These are just a few of these such resources that have had a big impact on VoIP development.

Application	Description
OpenSIPStack	OpenSIPStack provides developers with a platform agnostic stack implementation of RFC 3261 so that development can be done in Linux, Solaris, BSD, Darwin and Windows. This versatility has made it an ideal choice for developers wanting to work in a variety of platforms.
GNU oSIP Library	Developers wanting to work with SIP have found just about everything they need in this library. Described as having the aim to “provide multimedia and telecom software developers an easy and powerful interface to initiate and control SIP based sessions in their applications” the GNU oSIP Library can do just that as it includes not only a library but examples of programs that use the oSIP protocol to operate.
Twisted	Twisted comes from Twisted Matrix Laboratories and is an “event driven networking engine written in Python.” It supports a variety of protocols ((including HTTP, NNTP, IMAP, SSH, IRC, and FTP) and also has support for SIP, making it ideal for VoIP development.
Verona	The Verona Project is an open source VoIP toolkit based on a phone API called Phapi and a minimal user agent called aptly miniuu. It is similar to the toolset used in the highly successful OpenWengo software but is modified to reduce dependence on certain libraries, allowing users reliable building blocks for constructing their own VoIP programs.
PJSIP	Written in C, PJSIP is an open source protocol stack for SIP. Due to its small footprint, high portability, customizability, and loads of other features it has become a popular choice among SIP developers.
eXosip	The eXosip library is a common choice among those who want to take the complexity of using the SIP protocol for multimedia session establishment down a notch. eXosip hides it, and makes implementing SIP easier whether you're using it for VoIP or for something like multiplayer gaming.
Vovida SIP	Vovida is a hugely popular place to get VoIP software both to use as is and like this protocol stack, to be used more commonly in further development of VoIP programs. This SIP stack is popular with Linux based developers wanting to embrace this protocol.
reciprocate	Part of SIPFoundry, reSIPProcate works in a variety of operating systems including Unix, Windows, Mac OS X and more. The application is well suited and widely used in companies wishing to implement phones, softphones, gateways, proxies, or instant messaging.

Source: <http://www.virtualhosting.com/>, 2008

5. Developers

While anyone is able to edit and create parts of open source software, the original programming has to come from somewhere. These are a few developers that have had great

Creation of Value with OS Software in the Telecommunications Field

success in creating and releasing many of the most popular and widely used VoIP technologies in the open source field today.

Application	Description
SIPFoundry	SIPFoundry is a not for profit open source community that aims to support the development and adoption of the SIP protocol. It's also the home of much of the development of the sipX PBX for Linux, an award winning open source PBX program. The success of the sipX project as well as the increasing popularity of SIP have brought the SIPFoundry to the forefront of the VoIP community.
Pingtel	Pingtel's unique approach to the VoIP market may have a lot to do with their success. Using a system that runs using Linux and the sipX, Pingtel hopes to give business more control over how VoIP is built and used within their communications, something that proprietary software often can't offer. The company also prides itself on providing reliable support and service for their products, making many businesses more willing to use them as there is less risk if something goes wrong.
Vovida	Vovida is home to numerous SIP protocol stacks to help developers create and innovate new VoIP technologies and programs. Acquired in late 2000 by Cisco systems, this company's work is well funded and its VOCAL tools and software have helped push VoIP development forward.
Sangoma	Sangoma is a Canadian based company that develops both hardware and software based on the open source model, especially that having to do with telephony. While popular in North America, Sangoma is capitalizing on the hotbed of tech activity in Asia by forming a partnership with Vietnamese telephone distributor Dinh Quang. Their extension of open source VoIP software into new and widely used markets made them one of the most successful VoIP open source developers of 2007.
Digium	With over a million downloads, Digium is one of the leading providers of Asterisk's open source PBX software and has been the recipient of several awards for best open source software. With continued growth, and the acquisition of smaller VoIP players like Switchvox, Digium continues to add to its VoIP arsenal and likely will remain at the forefront of VoIP developers in years to come.

Source: <http://www.virtualhosting.com/>, 2008

Annex R – Validation Interviews

Name: Engº Luís Morgado

Entity: Rumos

Date: 24/11/2008

Subject: Formation in OS technologies

1. Em que tecnologias a Rumos iniciou a sua actividade de formação? Quando é que a Rumos decidiu apostar também na formação em tecnologias Open Source?

A Rumos fundou a sua actividade há 16 anos (em 1992). Na altura, a nossa intenção foi focar exclusivamente no sector da comercialização certificada, numa aposta de parceria com a Microsoft.

No ano 2000 criamos uma parceria com a RedHat, com vista ao estabelecimento de uma formação certificada em tecnologias open source. Avaliamos o mercado e verificamos que existia uma lacuna a este nível. Contudo, esta não foi o nosso primeiro passo na formação em tecnologias open source. Alguns anos antes lançamos programas de formação em Linux e administração de sistemas que não possuam certificação.

2. A Rumos considera expandir a sua actividade para a formação de outras tecnologias Open Source? (Php, MySQL, Plone, Python, Asterisk?)

É uma possibilidade em aberto. Nesta altura possuímos formação não certificada em tecnologias open source nas seguintes áreas:

- Java (J2EE, Java Beans, Framework spring);
- Linux backtrack (area de segurança);
- Apache
- PhP
- XML e UML

Neste momento, não equacionamos a curto-prazo ter uma formação em Asterisk, devido ao mercado em Portugal não o ter solicitado. Agora, a empresa está atenta à área do VoIP e pretende migrar os seus sistemas de telefonia para IP.

3. Qual a vantagem da formação certificada face à formação não certificada?

A formação certificada permite seguir um formato normalizado e bem estabelecido e que é referência a nível mundial. Para além disso, esta certificação possui a realização de exames de certificação. No caso das formações certificadas, os formadores têm obrigatoriamente que ter certificação de formação nesta área.

4. Quem são os clientes tipo das formações em tecnologias OS (utilizadores individuais, entidades públicas, empresas privadas)?

No caso da formação RedHat, diria que 80% dos nossos clientes são do sector empresarial. Dois clientes importantes nesta área são a Portugal Telecom e a Sonae.

Se falarmos em Apache e PhP diria que o nosso grande cliente é a administração pública através da parceria que temos estabelecida com o IGAP. Contudo, esta área de formação não tem uma grande expressão.

5. Qual o perfil tipo dos formadores em tecnologias OS? É muito diferente dos formadores em tecnologias proprietárias?

No nosso caso, a resposta é não. O nosso formador possui certificação em RedHat e Microsoft. Para nós esta polivalência revelou-se bastante importante. Na altura da sua contratação, o formador já possuía conhecimentos avançados em Linux, mas não tinha qualquer certificação nesta área. Foi portanto necessário fazer um investimento inicial na sua certificação.

6. Considera possível que uma empresa aposte unicamente na formação em tecnologias Open Source?

Sinceramente acho muito difícil. O mercado de formação em tecnologias open source é ainda relativamente pequeno. Contudo, este é um mercado que se encontra em crescimento, e foi o único mercado de formação que cresceu durante o ano de 2008 na nossa empresa. Acredito que o interesse pela formação na área de Open Source se faça mais na componente de desenvolvimento e administração de sistemas do que em produtos finais.

Name: Engº Rui Gouveia

Entity: GlobalTek

Date: 20/11/2008

Subject: Formation in OS technologies

1. Em que área de actividade se insere a empresa GlobalTek (formação, consultadoria, apoio técnico em soluções OS)? Qual é o motivo para se posicionarem em várias áreas da cadeia de valor?

Antes de responder a esta questão gostaria de informar que a GlobalTek surgiu como uma “spin-off” da Faculdade de Ciências da Universidade do Porto.

Inicialmente a nossa atenção seria centrar a nossa actividade unicamente na área de formação em tecnologias open source. Contudo, e apesar de praticamente não existir concorrência em Portugal nesta área, também não existe um grande número de clientes interessantes. O agendamento das formações só se tornam financeiramente viável de serem ministradas quando existem pelo menos um conjunto de 5 pessoas interessadas. Infelizmente, nem sempre tem sido fácil atingir este número.

Assim, e de forma a diversificar o risco da nossa actividade e capturar novos clientes, decidimos estender a nossa actividade para a área de consultadoria, apoio técnico ao domicílio e construção de sites dinâmicos. Curiosamente, e apesar de existir uma maior concorrência nesta área, a criação de sites dinâmicos com base na plataforma Drupal tem tido alguma receptividade. Paralelamente, também temos tido algum trabalho na área de suporte técnico ao utilizador, mas mais em ambiente Windows. Felizmente o nosso técnico tem uma grande versatilidade para trabalhar em Linux ou Windows. Por fim, outra área que tem suscitado algum interesse é a área de administração de servidores Linux.

2. Que tipos de formação é ministrada pela empresa (Linux, processamento de texto, aplicações Linux tradicionais)?

Efectuamos, até ao momento, formação em três áreas:

- Administração de sistemas Linux;
- Linux no desktop, onde também incluimos uma formação em Thunderbird;
- Processamento de texto com recurso ao OpenOffice.

3. A empresa tem interesse em expandir a sua área de formação em outras tecnologias OS (Apache, PHP, Python, Asterisk, Plone/Drupal)?

Sim. Existe interesse da empresa, mas que para tal se venha a concretizar torna-se necessário que exista know-how interno nestas áreas e clientes interessados. Por exemplo, estender a nossa formação para LAMP e OS web-based é perfeitamente viável no curto-prazo.

Incluir formação em Asterisk será um pouco mais complicado. Nós não possuímos know-how interno nesta tecnologia. Contudo, se o mercado estiver interessado, poderemos recrutar um formador nesta área.

4. Quem são os vosso principais clientes das formações (utilizadores individuais, entidades públicas, empresas privadas)?

O perfil tipo de um nosso cliente é um utilizador comum, que se encontra curioso sobre a utilização de tecnologias open source. Até ao momento, apenas tivemos um formando oriundo de uma empresa, cujo curso foi pago por esta mesma empresa.

Na verdade, a minha opinião é que precisamos de ter uma imagem mais credível na praça, para que outras empresa venham solicitar os nossos serviços.

5. Considera possível que a empresa GlobalTek forneça formação a outras empresas que integram e comercializam soluções open source?

Acredito que seja possível. Aliás, actualmente já existe uma parceria entre a Neoscópio e a GlobalTek. Em alguns projectos actuamos em consórcio, na qual a GlobalTek fica responsável pela área de configuração e administração de servidores Linux e pela sub-contratação de formação aos utilizadores finais.

Contact Name: Prof^o Dr^o Kevin Crowston

Activity: Full professor at Syracuse University School of Information Systems

Subject: Development model of open source software

1. Will the participation of end-users in the OS community (and not only developers) give to OS solutions better usability? Or, on the other side, is the OS community always more concerned with functionality requirements, instead of the usability component?

I don't think we can state it quite so simply. Developers have different interests as do users. Sometimes, it's important to have the collaboration of end-users in this kind of projects; however, the terminology of OS and its own culture brings some additional problems to a person that it isn't used to participate in the community.

2. How is it possible to avoid that the members of OS community working in the same part of the code? Are the actual coordination mechanisms, such forums, mailing lists, chats enough to guarantee this coordination?

In most projects there is some specialization in interests so, most of the time, people work on different parts. In the case they don't, then collisions are resolved by the source code control system.

3. Imagine an OS project where we have members with different motivations, like students at university, teachers/researchers, end-users and IT staff working at a private company. If that private company starts to get interested in this OS project and sponsors it, is there a risk that the other members of the OS community decrease their interest and motivation to keep working in the project? Is this a real risk or not?

Well, it's definitely a problem having a project dominated by a private company. In Apache, for example, projects need to have a diversity of members. It's possible to have the participation of a private company, but there is always a risk, especially when the competences of both parts are not totally clear.

Contact Name: Dr. Robert Shoe

Activity: VP and Business Development at StarPound Technologies (Atlanta Bay area)

Subject: Integration of OS unified communications applications

1. Nowadays, IT companies look to software more as a service rather than a product. Is this approach more suitable for SMEs (small and medium enterprises) or big enterprise clients?

The trend of Software as a Service (SaaS) began really by focusing on providing top-tier services for smaller customers. However, the adoption rate among larger organizations has continued to grow, especially as they realize the cost-benefit and efficiencies in the model at the enterprise level. One of the things that we're seeing is that a down economy is a boon to good SaaS companies.

2. In your opinion, will the appearance of unified communications appliances increase the vulnerabilities of an IT network?

Any new innovation or technology model is going to introduce new security risks, but I don't think it skews it one way or another. If you look back at the past 20 years, most major innovations in architecture introduced security concerns (e.g. Client/Server, Internet Banking, etc.). You plug the holes and evolve.

3. One key factor for the success of a unified communication approach is the integration among different internal applications of a company such, ERP, CRM and CMS systems. Can this integration be easily made between different OS products? Is it also possible to do with proprietary solutions or not?

This is the beauty of web services. When applications expose their data and processes through secure web services accessible via protocols such as SOAP or REST, it opens up the playbook for vendors to integrate. Proprietary solutions are no different. As long as there is

access to data through either a web service (public or private) or direct data access, integration is possible. Even proprietary software vendors are offering web services to their data these days - they have to as it is expected.

Contact Name: Eng. Martin Michlmayr

Activity: Open Source Community Expert at HP's Open Source Program Office

Subject: Open Source Licenses and Legal Support

1. In my PhD project I considered that GPL license can't be linked with proprietary software (since linked software is considered a whole). How is it possible to integrate an open source project, which its license is GPL, in a proprietary solution?
You cannot put GPL code into a proprietary application or link GPL and proprietary code. However, proprietary code can call independent GPL applications. So you could, for example, have a command line utility that is GPL, and then the proprietary application can run this command line utility for various tasks.

2. The GPL license is incompatible with licenses that contain an advertising clause. Are there ways to deal with this issue?

I'm not sure about this question. I suggest you ask Russ Nelson <nelson@crynwr.com>

3. The Software Freedom Law Center (<http://www.softwarefreedom.org/>) is an entity that provides legal services to the Free and Open Source software. In your opinion, is the existence of this entity very important for commercial companies that provide OS solutions?

The SFLC is very important, both for non-profit and for commercial companies. The SFLC provides a lot of information about how to comply with FOSS licenses. And they will have private talks with companies and organizations to give them advice.

4. Do you know other entities that provide legal services for Open Source software? Are all of these services offered freely (without costs) to the customer?

I'm not sure how many there are that do it for Free. The FSF has a GPL compliance lab that provides advise. The FSFE has a Freedom Task Force that provides some information and advise. But there are many commercial legal services. I maintain an (incomplete) list of such legal services at <https://fossbazaar.org/?q=resources/legalServices>

Contact Name: Dr. Mark Hinkle

Activity: Vice President of Community at Zenoss Inc.

Subject: Types of OS licenses and their integration with proprietary software

1. In my PhD project I considered that GPL license can't be linked with proprietary software (since linked software is considered a whole). How is it possible to integrate an open source project, which its license is GPL, in a proprietary solution?

Well I think that your interpretation of linked software may differ from others. I think many of the OSS companies like SugarCRM provide solutions which include GPL code and

Proprietary extensions. The big question here is that we can't use GPL software with proprietary software, without release the solution as GPL. But, if we do that, we can always release the same "integrated software" using others licenses. But a GPL version shall always exist.

2. In your opinion, will the actual license proliferation increase or decrease the interest of IT commercial companies by Open Source projects?

I am sure licensing proliferation will be a problem. As long as the OSI continues to add licenses as they did for Social Text and Microsoft recently.

3. The Software Freedom Law Center (<http://www.softwarefreedom.org/>) is an entity that provides legal services to the Free and Open Source software. In your opinion, is the existence of this entity very important for commercial companies that provide OS solutions?

For commercially backed OSS companies I don't think that the SFLC is a resource; only for those projects without corporate backing.

4. In your opinion, what is the actual level of participation by commercial companies in Open Source projects? Is it already relevant or residual? Do you think that it will improve during next years?

I think this varies, the companies that maintain their own core technology as due SugarCRM, MySQL, Alfresco, Zenoss, etc. will always be good, though I think there is no generalization that can address the question. I think that, as an overall trend, where more companies use OSS in their products you will see a lower degree of participation as a whole.

5. Do you think that the GPL license is one strong limitation for the participation of commercial companies in more OS projects?

I think it's limiting only in the way you commercialize not in the ability to do so. Red Hat, Novell, and so many of the other commercial OSS companies that are successful seem to be using GPL.

Contact Name: Prof^o Dr^o. Lawrence Rosen

Activity: Lecture at Stanford Law School and President of Rosenlaw & Einschlag Inc.

Subject: Types of OS licenses and its integration with proprietary software

1. In my PhD project I considered that GPL license can't be linked with proprietary software (since linked software is considered a whole). How is it possible to integrate an open source project, which its license is GPL, in a proprietary solution?

There is a vigorous dispute around that issue. As for me, I have written extensively that functional linking is not eligible for copyright protection (17 USC 102(b)). Independent works (in the copyright sense) can be linked together for functional purposes, and of course an open source license can't prohibit linking (see Open Source Definition, OSD). The GPL does not prohibit linking to independent copyrighted works.

You should be able to find lots of that discussion in the archives of Open Source Initiative (OSI).

2. In your opinion, will the actual license proliferation increase or decrease the interest of IT commercial companies by Open Source projects?

Confusion about licenses--caused in part by license proliferation, but often just due to confusion about copyright and patent licensing for software--always is a disincentive to increased use. But many of us work hard to prevent unnecessary license proliferation. That's why I published my book and still publish extensively on these issues.

See, for example, www.rosenlaw.com/LicenseProliferation.pdf

3. The Software Freedom Law Center (<http://www.softwarefreedom.org/>) is an entity that provides legal services to the Free and Open Source software. In your opinion, is the existence of this entity very important for commercial companies that provide OS solutions?

In my opinion this entity is especially important for developers who use the GPL. The companies already have their law consultants that can make this service. However, in some situations, especially for start-up companies this can be useful.

4. Do you know other entities that provide legal services for Open Source software? Are all of these services offered freely (without costs) to the customer?

Many open source attorneys write and speak freely and try to educate people for free or low-cost. Some of us provide pro bono legal services to some non-profit clients. (I did so for years for OSI and still do so for Apache Software Foundation.) How many programmers do you know who offer free programming directly to commercial customers?

Contact Name: Eng. Andrew Back

Activity: Open Source Strategist at BT Osmosoft

Subject: Use of Open Source software and its market trends

1. Which are the main reasons that justify the continuous growing of OS community?

I believe that we have entered a phase of mass adoption, as for example even previously proprietary-only vendors start to embrace open source to some extent, and increasingly organizations come to realize the value it presents, thus more solutions are produced and the community continues to grow. This is just a natural growth of the community as open source becomes more mainstream and gains widespread acceptance. At the same time organizations are starting to recognize that to realize the full potential from open source you have to participate, and so perhaps those who were early adopters, as consumer only, are now moving to the next phase, as their understanding of the paradigm and its wider benefits develops. This would see a shift whereby many who previously only consumed open source progress to become an active member of the community, resulting in growth.

As the Enterprise develops its understanding of open source the need for governance becomes clear, whilst some may also seek to self-support, and this creates a market for tools

and services to support such activities. Companies move in to meet these needs, and again the community grows.

2. In your opinion, are the emergent countries like India, China and Brazil more interested to participate and use OS projects/solutions than big stable economies like USA and UK?

I believe that open source provides a levelling framework for collaboration between emergent countries and the developed world. It supports in-country enterprise and thus benefits local economies, combined with the elimination of software acquisition costs and other benefits, explains why open source might be a higher priority in emergent countries than in the developed world. It is a stronger need, and in certain cases may be even the only option available.

3. In your opinion, the actual scenario of economical recession in the most important worldwide economies, will increase the interest of government and private companies to use open source software?

Open source presents a significant opportunity for many companies to reduce their operating cost base, and this combined with the current financial crisis may serve to accelerate the adoption of open source software. As the pressure increases to reduce operating costs, senior management will be receptive to initiatives that support this.

4. Which would be the most important 2 or 3 policies that European Union could implement to increase the adoption of FOSS by the government of each European Union (EU) countries?

It has been suggested that procurement policy should have a strong bias toward open source solutions, e.g. proprietary solutions are 'marked down' in ITT responses, thus promoting development of solutions that can be reused across the EU, and wider, without incurring incremental licensing costs. It has also been suggested that open source has the potential to deliver systems which have both a greater degree of transparency and are more easily maintained, e.g. see: <http://www.bricklin.com/200yearsoftware.htm>.

I believe education policy should promote, or even mandate, use of a high proportion of open source technology in schools and at universities. Such that, not only are savings made resulting from a reduction in software licensing costs, but open source skills become more prevalent.

I believe that policy should mandate use of open document standards for all communications and publications, both internal and external.

Name: Eng° João Belo

Entity: Marketing manager at Critical Links

Date: 21/11/2008

Subject: Management analysis of edgeBox solution

1. Quais são os critérios usados pela Critical Links para selecção dos vossos parceiros internacionais (revendedores)?

O mais importante para nós é a experiência que estes parceiros têm ao nível da remenda de equipamentos e servidores. Para além disso, é importante avaliar a motivação e empenho destes parceiros, nomeadamente ao nível de adoptar um solução tipo “one-to-box”.

Usualmente obtemos o contacto destes parceiros a partir das base de dados de empresas existentes em cada país e fornecidas pelo ICEP e através de presenças em feiras internacionais, onde damos a conhecer os nossos produtos.

2. Qual é a estratégia seguida pelos revendedores da edgeBox? Vendem directamente a solução edgeBox no mercado ou incorporam a edgeBox nas suas soluções finais?

A grande maioria dos revendedores vende directamente a solução “edgeBox”. Contudo, temos alguns casos pontuais em que os revendedores adaptam essa solução e depois vendem-na no seu mercado alvo, com outra designação. Temos, por exemplo, o caso da HCL que adapta a edgeBox e depois a coloca no mercado como netEdgeBox.

3. Como é realizado o vosso suporte técnico (para revendedores e clientes finais)?

O suporte técnico aos nossos revendedores é efectuado directamente junto da equipa técnica do revendedor. Existem duas opções: os revendedores deslocam-se até às nossas instalações ou a nossa equipa técnica ministra esta formação junto do revendedor.

Para os clientes finais oferecemos um suporte de 3 níveis. Temos um helpdesk localizado em Coimbra, que é formado por pessoal com formação técnica na área de administração da edgeBox.

4. A Critical Links estaria interessada em obter serviços de consultadoria legal ao nível de integração de soluções open source em soluções comerciais?

Neste momento, este trabalho é efectuado pela nossa equipa de advogados. Considero que este é um trabalho com base puramente legal, onde os aspectos técnicos não são relevantes. Não é uma prioridade para a Critical Links mudar este actual paradigma, pois não temos tido problemas nesta área.

Apesar de não ser uma prioridade, penso que estes serviços de consultadoria poderiam ter interesse numa fase anterior, à da colocação do produto no mercado. Neste caso, poderíamos ter algum aconselhamento de como fazer esta integração de uma forma segura e de forma a evitar problemas legais num futuro. Depois, e caso estes problemas legais surjam, a equipa de advogados é indispensável.

Name: Prof^o Dr^o Raúl Oliveira

Entity: CEO of iPortalMais

Date: 21/01/2009

Subject: Management analysis of IPBrick.GT solution

1. Existe uma correcta percepção dos clientes da proposta de valor de comunicações unificadas e dos seus benefícios para a actividade empresarial?

O cliente dá sobretudo valor ao IP-PBX. É esta actualmente a sua principal necessidade. Contudo, a iPortalMais oferece a IPBrick.GT que é uma solução que possui um IP-PBX e oferece um conjunto alargado de serviços. Esta solução de comunicação unificada tem um custo bastante mais baixo face aos seus concorrentes comerciais, como a Siemens ou a Nortel, e possui um conjunto mais alargado de serviços do que outra solução de IP-PBX, sendo o seu preço típico ligeiramente superior.

Para a iPortalMais oferecer uma nova solução IP-PBX não seria rentável, pois existem muitos competidores neste mercado. Contudo, oferecer uma solução de comunicação unificada a baixo custo passou a ser uma vantagem competitiva importante para os nossos clientes. Muitas vezes, os clientes não têm a percepção exacta das mais valias da solução, mas encaram-na como uma solução de comunicação do futuro e que terá benefícios a médio e longo-prazo.

2. Qual é a estratégia seguida pelos revendedores da IPBrick? Vendem directamente a solução IPBrick no mercado ou incorporam a IPBrick nas suas soluções finais?

A IPBrick.GT é uma solução única, mas como possui um sistema operativo aberto, permite que outras aplicações sejam instaladas sobre esse sistema operativo. Este é um conceito bastante diferente face aos restantes competidores no mercado, que oferecem uma solução de comunicação unificada fechada para o exterior e bastante limitada em termos de construção de novos serviços.

A inclusão de novos serviços sobre a arquitectura da IPBrick.GT pode ser realizada tanto pelo revendedor como pelo cliente. Por exemplo, temos um cliente que resolveu instalar um sistema de video-vigilância sobre o IPBrick, permitindo tirar vantagens de existir um sistema de comunicações IP, e usando este sistema IP durante a noite, período em que tipicamente o sistema de comunicações da empresa se encontrava desligado e a não gerar valor para a empresa.

3. Os revendedores da solução IPBrick são parceiros exclusivos ou não?

Temos alguns parceiros exclusivos que só usam ferramentas disponibilizadas pela iPortalMais, mas na sua grande maioria, os parceiros não são exclusivos e fornecem outras soluções de outros fabricantes como a CISCO, Nortel, Siemens ou Microsoft.

4. A iPortalMais preocupa-se em medir o grau de satisfação dos seus clientes? Como é obtida esta informação?

Não existe actualmente uma ferramenta efectiva que permita medir esta informação. Tipicamente o suporte é efectuado directamente pelo revendedor junto do cliente, o que indica que esta informação é melhor controlada pelo revendedor. Contudo, temos tido um

contacto bastante regular com alguns dos nossos clientes, que nos contactam directamente quando não conseguem resolver um problema na sua estrutura de telecomunicações recorrendo ao revendedor. Neste caso, o custo deste suporte é cobrado directamente ao revendedor, que em alguns casos não reage muito bem perante esta situação. Temos consciência que o cliente normalmente encontra-se satisfeito com a nossa solução e com o nosso serviço técnico, mas o serviço técnico prestado pelos nossos revendedores não é eficaz em algumas vezes.

5. Perante o actual cenário de recessão económica é de prever que as empresas adiem importantes investimentos na sua área tecnológica. Assim sendo, é previsível um decréscimo da procura de soluções de comunicação unificadas no curto-prazo. Como é que a iPortalMais olha para esta situação? Qual é a sua estratégia de acção?

Acredito que o actual cenário de recessão económica pode até ser vista como uma janela de oportunidade para a iPortalMais. Na verdade, as empresas vão ter sempre necessidade de novos sistemas PBX e o IP-PBX fornecido pela iPortalMais pode se revelar uma escolha acertada. Em primeiro lugar, no mercado nacional, a nossa solução IPBrick possui um custo inferior perante os restantes competidores. No mercado internacional, temos consciência que a nossa solução é mais cara que outro concorrente IP-PBX, mas o IPBrick.GT inclui um sistema de comunicação unificadas que os outros não possuem, e os concorrentes de soluções de comunicações unificadas possuem um custo muito superior ao IPBrick.GT.

Name: Drº Miguel Ferreira

Entity: Financial and Logistic Manager at Critical Links (New Jersey office)

Date: 23/12/2008

Subject: Management analysis of edgeBox solution

1. Quais são os principais critérios usados pela Critical Links na selecção dos seus revendedores internacionais da solução edgeBox?

O principal critério prende-se com o nome que os revendedores têm nos mercados internacionais (como exemplo temos a HCL - Índia).

Obviamente que quanto maior (mais conhecido) for esse revendedor, menores serão as margens de lucro para a Critical, o que implica algum bom senso na escolha dos mesmos. A negociação aqui assume um papel chave.

Existem também alguns revendedores mais pequenos (principalmente nos US) e cujos critérios não têm tanto a ver com o facto de serem conhecidos internacionalmente, mas sim pelo facto de abrangerem um vasto mercado interno.

2. A edgeBox é tida uma solução única e inovadora no panorama internacional. Contudo, e apesar de esta informação continuar a ser verdade, surgem no mercado cada vez mais soluções de comunicação unificadas que podem realmente desempenhar um papel semelhante à edgeBox. Assim, de que forma se pode sustentar esta vantagem competitiva a longo prazo, nomeadamente em mercados em que a edgeBox não é tão conhecida?

A principal vantagem competitiva da edgebox está no facto de ser um produto que está muito mais desenvolvido que os seus competidores. Se por um lado isto é uma vantagem competitiva, por outro também lhe tem trazido alguns problemas, nomeadamente quando é colocada em funcionamento nas empresas (pois as empresas nunca conseguem tirar partido de todas as suas funcionalidades...)

De forma a sustentar a sua vantagem competitiva é necessário continuar a desenvolver o produto e ao mesmo tempo simplificá-lo... A simplificação do mesmo é obrigatória para que a edgebox consiga sobreviver.

Quanto aos vários mercados, muito sinceramente penso que a Critical deve apostar em 2 ou 3 mercados chave e esquecer os outros, pelo menos para já. Há que construir as bases em mercados como o Norte-Americano que sirvam depois de alavanca para os restantes.

3. Penso que as principais estruturas de custos da edgeBox se situam ao nível dos recursos humanos, assemblagem/montagem do produto e logística da distribuição. Gostaria de saber onde se realiza a montagem da edgeBox, nomeadamente se existe um local pré-fixo ou encontra-se dependente do mercado final do consumidor? Em que medida são importantes os custos da logística de distribuição relativamente aos custos em RH?

Sim, os principais custos são as instalações e os RH. No entanto, os custos de RH são menores do que se pensa, uma vez que em Portugal faz-se o desenvolvimento do software que depois é enviado para um fornecedor norte americano que faz a montagem da edgebox. A Critical só tem de se preocupar em enviar o software para o fornecedor que depois cria e envia a edgebox para os clientes da critical (com base numa ordem de saída).

O local é somente um, nos US. A critical estava a trabalhar com a Steelcloud (perto de Washington DC), no entanto encetou negociações para mudar para a Advantec também nos US.

Os custos de logística são mínimos. A critical paga um “fee” por edgebox que sai do fornecedor (eles é que tratam do envio para o cliente final).

4. Na análise SWOT que efectuaste da Critical Links, mencionaste como uma das ameaças a legislação diferente existente entre vários mercados. Podes concretizar esta tua visão? Em que situações isto se torna visível?

A critical envia edgeboxes para todo o mundo e por vezes é bastante complicado lidar com a legislação dos vários países, uma vez que exportar dos US implica muitas vezes o pagamento de taxas alfandegárias, impostos, etc. O não conhecimento da legislação para onde se está a enviar o produto pode tornar-se numa verdadeira dor de cabeça e implicar atrasos na entrega do produto.

Para ultrapassar este tipo de problemas normalmente é necessário contactar as autoridades alfandegárias dos países de destino ou falar com o cliente e tentar perceber o tipo de problemas que podem surgir no momento da entrega.

Name: Eng^o Tito Vieira

Entity: Director of CICA Informatics Support Center of FEUP

Date: 6/11/2008

Subject: Management analysis of PolySpeak solution

1. Quais foram as razões que motivaram a Faculdade para o desenvolvimento interno da sua solução de VoIP (para além dos custos de licenciamento)?

A faculdade pretendia estar numa posição de liderança tecnológica e acompanhar o restante mercado que começava a olhar com muito interesse para as soluções de VoIP. Uma solução de VoIP iria trazer importantes benefícios para a nossa organização, tais como: diminuir os custos de comunicação, maior independência face aos operadores tradicionais e aumento da flexibilidade de comunicação dos colaboradores.

No segmento comercial já existiam algumas soluções de VoIP, mas que eram bastante limitativas em termos de funcionalidades disponíveis e os custos de licenciamento eram muitos vezes proibitivos para nós. Para além disso, estes custos de licenciamento da solução dependiam muitas vezes do número de utilizadores que usavam a plataforma, o que para nós seria impensável. Optamos também por desenvolver internamente a nossa solução de VoIP, pois isto permitiria-nos aumentar a inovação tecnológica dentro da nossa instituição e possibilitaria aproveitar as fortes competências técnicas dos nossos colaboradores. Está claro, que foi necessário re-alocar alguns dos nossos colaboradores da área de redes, mas isto acabou por ser conseguido sem grandes problemas.

2. Quais são as principais razões que justificam a cedência de uma licença de comercialização do PolySpeak à Suprides? Por que razão a opção não recaiu na criação de uma “spin-off” a partir da FEUP?

A vocação e motivação da faculdade é trabalhar na área de inovação tecnológica, desenvolvimento de soluções e transferência tecnológica. A nossa principal vocação nunca foi a instalação e configuração da nossa solução junto dos nossos clientes.

Assim, decidimos disponibilizar a nossa solução perante os eventuais parceiros comerciais interessados. A Suprides mostrou-se interessada e concluímos que poderia ser um parceiro interessante. Contudo, um dos aspectos que estabelecemos logo à partida é de que não existiria qualquer contrato de exclusividade com nenhum parceiro comercial.

No final do período do contrato que é de um ano, analisaremos os resultados obtidos pelo parceiro e renovaremos o contrato se estes resultados forem positivos.

3. Tem sido mais simples cativar o interesse e aplicar esta solução de comunicação junto do sector privado ou dentro do sector público (no qual se incluem outras faculdades e universidades)?

Temos actualmente uma situação híbrida, na qual esta solução é adoptada por entidades públicas e empresas do sector privado. Contudo, e infelizmente, não existiu consenso para o

estabelecimento desta solução a nível universitário. Pelo menos, e devo dizer que fiquei desapontado, pela universidade do Porto não ter mostrado interesse em adoptar esta solução por todas as faculdades que constituem a UP. Acredito que teria sido possível criar um projecto piloto numa outra faculdade para aferir da viabilidade da implementação desta solução fora do ambiente da FEUP.

4. A FEUP equaciona ou encontra-se preparada para fornecer serviços de consultadoria na área do VoIP para empresas do sector privado, nomeadamente para PMEs?

Sim. De facto, existe interesse e disponibilidade em que se venha a concretizar uma situação deste tipo. Aliás, o fornecimento de serviços de consultadoria é uma área em que a FEUP se sente mais à vontade do que a área de instalação de soluções finais. A área de transferência de conhecimento é uma das áreas principais da nossa actividade segundo os estatutos da UP.

Actualmente, nós não temos directamente recursos disponíveis para atender a eventuais pedidos nesta área. Contudo, tal como no caso de desenvolvimento do VoIP, poderemos facilmente re-alocar recursos.

Name: Prof^o Américo Azevedo

Entity: Faculdade de Engenharia (FEUP – DEGI)

Date: 29/10/2008

Subject: Business analysis methodology and quality management

1. Considera a metodologia de Osterwalder para a análise de modelos de negócio a mais correcta? Aconselha outras abordagens?

Numa rápida análise, pois não conhecia esta metodologia, parece-me ser bastante simples mas simultaneamente completa. Possui todos os elementos fundamentais. A identificação dos modelos de negócio é completa, faltando unicamente a apresentação dos processos de negócio. Por processos de negócio entende-se a infraestrutura tecnológica, recursos técnicos e humanos que se torna necessário possuir para operacionalizar o negócio. Muitas vezes bons modelos de negócio podem conduzir a fracas implementações.

Relativamente à parte do “assessment” gostaria de salientar que a análise SWOT é por vezes muito simplista. A sua real utilidade depende muito da profundidade com que é feita.

Por fim, a parte do “improvement” acaba por ser a mais importante. O eixo do tempo é o vector mais importante e que por vezes acaba por ser esquecido. Existem várias estratégias para a realização do improvement nomeadamente a incremental, a de ruptura e a de “benchmarking”.

2. Como analisa a problemática da gestão da integração de soluções? Considera que a integração de aplicações Open Source é muito mais simplificada devido ao uso de normas abertas?

Sim, caso estejemos a falar de open source com open standards. Aliás, só assim é que o open source se torna verdadeiramente útil. Aproveito para fazer a distinção entre soluções proprietárias, que quanto a mim são as soluções usadas especificamente por uma única empresa. As soluções comerciais englobam também as soluções de um fabricante de soluções

de open source. Outro aspecto a se ter em consideração é a existência de soluções proprietárias de “middleware” que tentam facilitar este processo de integração. Contudo, a minha experiência diz que este processo de integração é sempre mais complexo do que inicialmente se prevê.

3. Considera que os canais típicos de comunicação e distribuição do software livre são eficazes? Ou poderiam existir outros complementares?

A minha visão pessoal diz-me que esta é uma das principais lacunas do open source. Um aspecto crítico na escolha de uma solução tecnológica é a existência de suporte. Actualmente, o suporte existente na comunidade open source não me dá garantias. Quanto a mim as listas de discussões podem ser consideradas interessantes como um suporte de 1ª linha, mas não nos dá garantias de resolução do problema. Para além disso, considero que as listas de discussão se encontram mal estruturadas.

4. Como analisa os modelos de negócio típicos da web 2.0? Considera que os mesmos podem ser sustentados a longo prazo?

É uma pergunta muito interessante. Cada vez mais surgem modelos de negócio baseados na web 2.0 e que têm feito grande sucesso, como é o caso do eBay, MSN e do próprio Google. O importante é ter um modelo que contemple o aproveitamento de proveitos indirectos. Estes proveitos indirectos devem fazer parte do modelo de negócio e não devem ser esquecidos. Acredito que estes modelos podem ser sustentados a médio e longo-prazo, mas seria muito interessante que estes modelos de negócio não estivessem tão dependentes das receitas oriundas da publicidade.

Name: Prof^o António Moreira

Entity: Universidade de Aveiro (Management and Innovation Group)

Date: 19/12/2008

Subject: Innovation and Entrepreneurship with Open Source Software

1. Na sua opinião, o modelo de desenvolvimento do software livre inibe a inovação (uma vez que os investimentos em I&D dificilmente seriam recuperados num ambiente livre)? Ou, pelo contrário, considera que a conexão em rede e partilha de conhecimentos num ambiente de software livre fomenta a inovação?

Penso que deveríamos ter em consideração que a inovação é uma novidade que foi comercializada no mercado (strictu sensu). Assim sendo, penso que deveríamos falar em criatividade e não em inovação. No entanto para responder à sua pergunta vou ter em consideração a inovação como novidade (latu sensu).

Tendo em consideração o software livre, como resultado, podemos considerar que se trata de uma inovação dado que é uma alternativa ao software proprietário. É necessário termos em consideração o que é que foi financiado e como. Há institutos de investigação (e projectos) que são financiados com fundos públicos - sejam do Estado português, sejam da União Europeia – pelo que o investimento não teve como orientação o retorno do investimento mas sim uma perspectiva de tecnologia “pública” (mais concretamente de acesso a todos). Nesta perspectiva não me parece claro que se pretenda recuperar este I&D como sendo proprietário

de uma instituição (A outra face da moeda também é aceitável: tendo em consideração o risco associado aos projectos, parece-me razoável que se procure investir em projectos com maior rentabilidade, de forma a gerar fundos que financiem novos projectos...).

Penso que a conexão em rede permite a partilha de conhecimento, o que pode potenciar a inovação num ambiente de software livre. No entanto penso que devo ser incisivo: não potencia a inovação por se tratar de software livre mas sim pelo facto de haver partilha de conhecimento, o que permite uma maior internalização, externalização e difusão desse novo conhecimento.

2. Considera correcto considerar-se que o modelo de desenvolvimento do software livre fomenta o surgimento de inovações radicais, enquanto que o modelo de desenvolvimento de software proprietário fomenta as inovações incrementais?

Penso que a questão é “maliciosa”. Estamos a falar de tecnologias (como meios) que são utilizáveis pelo mercado ou de produtos (fins ou objectos)? Como vê, tudo depende da perspectiva. No entanto penso que tanto o software livre como proprietário podem fomentar as inovações incrementais como radicais, tudo depende da solução em vista e da sua utilização.

Penso igualmente que haverá situações em que a radicalidade das soluções é recompensada. Haverá situações em que as soluções incrementais sejam recomendáveis.

3. Considera importante que os jovens empresários usem o software livre, de forma a diminuir os custos com o licenciamento de software?

Há muito que deixei de ser engenheiro!! Os jovens empresários devem preocupar-se com os novos negócios, com a perspectiva de crescimento da empresa, com a competitividade das suas soluções e com a rentabilidade da empresa. Nesse caso, considero que o software é uma mera ferramenta pelo que sei qual o custo de licenciamento de software proprietário. Teria de analisar o custo da procura de informação, de conhecimento, de internalização desse conhecimento e de desenvolvimento de novas soluções. Como empresário estaria preocupado com o negócio e não com o meio (a não ser que o próprio software fosse o negócio da empresa).

4. Imagine que a empresa anterior actua no sector das tecnologias de informação e comercializa uma solução de software baseada em software livre. Considera possível que esta empresa sobreviva no mercado unicamente através de um modelo baseado em serviços? Ou terá que possuir sempre um modelo misto baseado em receitas de produtos e serviços?

Penso que ninguém compra tecnologias (os produtos corporizam as tecnologias, os produtos são oferecidos aos mercados, mas os mercados são pessoas!!!) comprem soluções ou serviços. Hoje em dia a sobrevivência depende essencialmente dos serviços que são assegurados pelas empresas (as donas-de-casa nem imaginam as tecnologias que estão embebidas nos produtos que compram para as suas casas. Os empresários também não querem saber das tecnologias, querem é soluções).

O “mix” produto/serviço vai depender do tipo de empresa, do tipo de serviço e do tipo de produto comercializado pela empresa. No entanto considero que o serviço é muito mais importante.

5. Considera viável que as universidades em geral desempenhem a função de consultores de empresas que integram e comercializam soluções de software livre? Digo isto, pois muitas vezes, grande parte dos membros mais activos da comunidade software livre são alunos, investigadores ou docentes universitários que possuem amplos conhecimentos nesta área, mas não existe uma efectiva transferência de conhecimentos e criação de valor para o sector empresarial. Qual é a sua opinião nesta área? Como é que as universidades se poderiam organizar?

Vou limitar-me às universidades portuguesas! Já leu o livro “teaching elephants to dance”? Na sua generalidade, são demasiado burocráticas, dependentes do estado e sem mentalidade de mercado para serem minimamente competitivas. Penso que se tivéssemos um mercado mais competitivo (veja-se a Holanda, RU, USA, Alemanha, ...) os bons investigadores das Universidades e dos institutos de investigação não estariam lá certamente.

Name: Prof^a Hortênsia Barandas

Entity: Faculdade de Economia (FEP)

Date: 13/11/2008

Subject: Marketing and internationalization strategy

1. Genericamente, qual é a estratégia mais adequada para uma empresa na área das tecnologias de informação para penetração no mercado internacional (delegações, distribuidores locais, parceiros locais)?

A estratégia a ser seguida por uma empresa depende sempre da natureza do próprio negócio e do mercado onde a empresa actua ou pretende actuar. Uma estratégia bem sucedida num mercado, pode não resultar num outro mercado, que possui características distintas. A cultura, a forma de se trabalhar neste mercado, a qualificação dos recursos humanos são elementos cruciais que caracterizam um dado mercado. Das três opções identificadas acima diria o seguinte:

Delegações locais – deve ser a estratégia a ser seguida, caso o volume de negócios o justifique, quando existe um bom conhecimento do mercado local e quando existem condições que garantam um correcto recrutamento de colaboradores;

Distribuidores locais – quando se pretende actuar num novo mercado, sem grande conhecimento do mesmo e a empresa não é uma “self-learning company”. Quero com isto dizer, quando a empresa não tem capacidade de aprender com a existência de um eventual parceiro;

Parceiros locais – esta é provavelmente a solução mais indicada para a grande maioria das empresas. Agora, as vantagens de seguir esta estratégia só são conseguidas quando a empresa tem capacidade de aprender com o parceiro, e a solução disponibilizada no mercado final é uma mais valia para o cliente final, e advém das competências únicas da conjugação de conhecimentos e capacidades das duas empresas.

2. Considera adequada a estratégia de penetração no mercado internacional com recurso a distribuidores de valor acrescentado, ou seja, que incorporam os produtos da empresa nas soluções finais oferecidas ao cliente?

Sem dúvida, aliás como tive oportunidade de mencionar na resposta à pergunta anterior. É de facto preferível a existência de uma parceria, no qual os parceiros possam fazer a adaptação do produto ao cliente final. Dois elementos fundamentais neste tipo de abordagem dizem respeito à correcta identificação dos parceiros e à negociação dos contratos. A natureza do contrato celebrado entre estas entidades pode inviabilizar num futuro que este parceiro se torne concorrente da própria empresa.

3. Quais os principais riscos inerentes à estratégia de comercialização de um produto no mercado internacional, exclusivamente com recurso à Internet?

De facto, este tipo de abordagem só resulta se a natureza dos produtos o permitir. Existem ainda significativos problemas em termos de logística que devem ser devidamente ponderados neste tipo de abordagem. Outras considerações a se ter em conta neste tipo de abordagem dizem respeito à forma de pagamento do cliente e do suporte técnico que o cliente necessita.

4. Qual é a melhor estratégia para se dispensar menos tempo e recursos em clientes que não geram lucro à empresa?

Um aspecto fundamental para qualquer empresa é a sua imagem de marca, reputação e notoriedade. Esta imagem de marca pode ser afectada se não se der a respectiva importância a estes clientes que, apesar de não gerarem lucro, são de grande importância para a preservação da imagem da empresa.

O “word-of-mouth” é fundamental na construção da credibilidade da empresa. A satisfação de todos os clientes é também um investimento indirecto em marketing, sobretudo na área das tecnologias de informação. Às vezes assisto a muitas empresas que têm políticas agressivas de marketing e que não se preocupam com a satisfação dos seus clientes de igual forma. Diria, que nestes casos, a sua estratégia de marketing é negativa para a empresa e vai influenciar a percepção da imagem da empresa no mercado.

Antigamente o grande objectivo de gestão dos CEOs era a maximização dos lucros das empresas. Actualmente, este paradigma mudou e o grande objectivo passou a ser a maximização dos benefícios para todos os “stakeholders” que permita o crescimento sustentado da empresa. Existe actualmente uma visão de maximização dos lucros partilhados de uma empresa.

Name: Prof^o José António Faria

Entity: Faculdade de Engenharia (FEUP – DEIG)

Date: 12/11/2008

Subject: Role of Quality Certification Entity

1. Considera que as soluções Open Source têm características próprias que facilitam o surgimento de soluções com elevada qualidade de software?

Existem algumas características que facilitam a criação de software mais robusto, como é o caso da larga comunidade de desenvolvimento, partilha de informação e inter-ajuda. A

qualidade do software open source é construída passo-a-passo de uma forma incremental. Normalmente, uma primeira “release” de uma solução OS contém diversos “bugs” que vão sendo posteriormente resolvidos com o lançamento de novas releases.

Contudo, e de uma forma global, eu confio mais num software comercial com certificação de qualidade do que num software open source. No software OS existe falta de uma estrutura formal mais rígida que nos possibilite ter uma certificação de qualidade tradicional, que se suporta em termos de testes e padronização de processos.

2. Considera importante que as empresas que comercializam soluções Open Source possuam certificação de qualidade ao nível de processos?

Existe, de facto, uma incompatibilidade de filosofias. A certificação de qualidade ao nível de processos assenta na padronização de processos e tira vantagem de uma empresa desenvolver produtos similares entre si, e que seguem uma estruturação bem definida. Este tipo de abordagem torna-se incompatível com a dinâmica da comunidade Open Source e com o grau de inovação dos seus produtos.

Acredito que seria importante a existência de algumas normas e regras que permitissem ter um grau superior de confiabilidade nas soluções open source. Contudo, estas normas e regras encontram-se ainda longe da actual visão de certificação de software que é demasiado formal.

3. Será possível estabelecer certificação de qualidade de software directamente no Open Source Provider (comunidade open source. Ex:SourceForge) ou apenas ao nível do Open Source System Integrator (empresa que integra num único produtos diversas soluções OS)?

Sinceramente não acredito que seja possível lançar-se uma certificação de processos ao nível do Open Source Provider. Devemos preservar as suas características únicas ao nível da agilidade e inovação das suas soluções. Ao nível de produto, seria interessante de existir um maior grau de padronização que permitisse evitar o lançamento de releases com demasiados bugs.

No Open Source Integrator esta certificação seria muito bem vinda. Agora, torna-se necessário definir um novo referencial, nomeadamente através do lançamento de uma nova certificação que atendesse às especificidades da comunidade OS e das características dos seus produtos e modelo de desenvolvimento.

4. Usando as actuais normas de qualidade de software, considera possível efectuar-se a certificação de soluções VoIP atendendo aos seus parâmetros de segurança e qualidade de serviço (QoS)?

Não conheço esta tecnologia em pormenor. Contudo, parece-me que são dois conceitos importantes e no qual a certificação poderia ter um papel importante.

5. Que entidades externas poderiam desempenhar o papel de certificação de soluções OS? Por exemplo, as actuais entidades certificadoras ou outras entidades poderiam surgir a desempenhar este papel?

Não acredito que as actuais entidades certificadoras pudessem desempenhar este papel. A sua estrutura é demasiado rígida para se adaptar ao modelo de desenvolvimento da comunidade OS. Agora, existe um espaço para surgimento de uma nova certificação lançada por outra entidade certificadora. Esta entidade deveria surgir internamente na comunidade OS, de forma a reflectir a sua cultura e modelos de desenvolvimento. As universidades ou centros de investigação podem desempenhar este papel, pois possuem membros muito activos dentro da comunidade Open Source.