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Innovation in Telecommunications

Proceedings of the Research Seminar on Telecommunications Business

Editor Sakari Luukkainen

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Preface

The success of Finnish telecommunications manufacturers in the 90's was influenced by the special characteristics of regional industrial structures and their internal dynamics. The domestic industry has especially benefited from Nordic GSM markets, which enabled those companies a forerunner position in the export markets. The liberal telecommunications policy also fueled local market conditions that preceded global diffusion of GSM. The basic mobile voice call was an evolution of from fixed network as well as NMT and GSM provided this service reliably and by good coverage right from the beginning.

Most recent development path in the mobile industry has been that the success of the GSM created excessive expectations of the market demand for the third generation mobile technologies. The original target of UMTS was not to increase capacity of basic voice services like in the GSM case, but rather to enable the convergence of Internet and mobile networks. 3G were then seen as a platform of fully integrated voice and data as well as fixed and mobile communications.

During this decade domestic business environment in mobile communications is completely different. Instead of innovation driven growth constant deregulation of Finnish markets has led to exceptional price competition and stagnated penetrations rates, which has commoditized GSM related mobile services. Only the roaming service prices have maintained their high levels. If so fast price decline and technological maturity precedes again global development, the whole value chain would require ever increasing cost reductions if new innovations and related business opportunities do not arise.

Mobile multimedia has been widely thought to be the source of new service revenue by which the benefits of high-speed mobile data network investments could be realized. Experiences related to WAP, MMS and mobile gaming applications have however showed that mobile data service diffusion is a complex process that contains remarkable market uncertainty. Currently mobile data services excluding the unxpectedly successfull SMS consist only a few per cents of operators' revenues. From the mass market and end user point of view mobile data services are discontinuous. The subscribers of 3G services have thus not grown on a level as it was expected and e.g. in initial pilots in Japan it was recognized that all services that consumers were interested in 3G were already available in their 2G network's I-mode concept. The introduction of video in mobile environment did not create enough value added. There are also now attemts to integrate mobile and digital TV networks and to provide mobile television service in such a hybrid network. It is interesting to see what happens to this novel approach in coming years and what is the right business model.

In generally among 3G there remains the problem related to market and especially to the end user needs. Because it seems that GSM networks are able to serve cost efficiently still long time all the demand related to basic voice call service, the only way for 3G to differentiate are the mobile data services. It has been however questioned the need for full wide area mobility in broadband applications and e.g. much more cost efficient WLANs can be relevant substitutes for 3G and have started to disrupt the operators walled garden business models. It is natural for most people to speak while driving or walking, but not to access Internet. Also the constraints of portable mobile devices like display size influence to the user experience. Similar service level cannot be provided in the mobile environment in which users have been accustomed in fixed ADSL Internet access or using portable laptop computers equipped with WLAN facility. WLANs are already working in the areas where people actually need wireless access like in cafes, hotels and airports while waiting. For mobile networks then remains the role of wireless access of passengers in trains, cars and busses, where the handover and thus mobility is naturally needed.

There future seems to be technologically fragmented again like in 1G. There are several USA originated alternatives emerging for wireless broadband access for rural areas also in the market of Europe like Wimax and Flash-OFDM. The history has shown that the markets and applications of new technologies develop in a very different way than engineers have originally thought. Also the success factors of the new technology cycles are not similar to what they have been in the previous ones.

This publication is a collection of research reports written during the course Research Seminar on Telecommunications Business at Helsinki University of Technology. The course is especially designed for students taking Telecommunications Management for their major but is as well suitable for all students that like to develop their techno-economic analysing skills in the telecommunications area. The aim of the Telecommunications Management major is to help the students to understand the structure and dynamics of economic life and industry with a special focus on the telecommunications by combining business and technology studies.

The course provides an opportunity to rehearse scientific writing and presentation skills. The goal of the spring 2006 seminar was to investigate the challenges service providers face when updating their network infrastructure to offer emerging mobile and wireless data services taking into consideration both business and fast developing technology requirements and possibilities.

As a result of hard work we have now a collection of interesting papers of several possible technological scenarios in mobile and wireless data networks. I want to thank all the contributors for their excellent papers as well as for the lively discussions during the seminar sessions.

Sakari Luukkainen, editor
July 3, 2006
Espoo, Finland

Contents

MOBILE SERVICES MARKET IN FINLAND

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Abstract

The aim of this paper is to give a general description of the current market characteristics in Finland. First there is brief introduction which gives an overlook of mobile market situation. After this a quick look at markets, market segments and players. Then the influence of recent price competition to the innovativeness of operators is studied followed by the influence of consolidation to price competition. Methods to increase customer loyalty are given a thought and influence of 3G terminal bundling to subscription is studied. Also a possibility for service differentiation and independent MVNO's role in service innovation is evaluated.
Focus of the work is to highlight the current and expected operator business models and non voice services.

Key Words
Mobile Service Markets, Price Competition, MVNO

1. Introduction

Finland is one of the leading countries in the world in the use of mobile telephones. There are approximately 5,3 million phone subscriptions in Finland (Haanperä 2006), which means that there are roughly one cell phone subscription per people. Finland has an excellent track record in developing and commercializing mobile telephone service. The analog NMT network was launched commercially in 1982 (Sarén 2001), the first commercial GSM network was opened in 1991 by Finnish operator Radiolinja (Häikiö 1998). Finland was also first to launch four competing 3G licenses. Licenses were given after "beauty contest" to Oy Radiolinja Ab, Sonera Oy, Suomen 3G Oy and Oy Telia Finland Ab (Sarén 2001). In 2001 the number of mobile subscriptions exceeded the number of fixed telephone lines (Vesa 2005). Finland was also one of the first countries were SMS-based text messaging became a success story. Number portability was introduced in Finland in 2003 and during the six-month period following the introduction over 310.000 subscribers (15%) switched operator (Vesa 2005). Operators have been trying to attract customers from their competitors by offering free airtime, large discounts in call traffics, and giveaways. As a result of this development, Finnish mobile phone users talk more than in the past, but mobile operators' revenue have not grown.

During the last years mobile industry has been changing its form. Business has been transforming from old voice based person to person (P2P) centric industry to data driven media-like person to content (P2C) centric non voice service industry. Instead of simple voice calls consumers are now offered also network access in order to support diversified service contents, so called three A's: Anywhere, Anytime, Anything.

One of the key drivers of the current shift from the traditional voice-centric mobile telephony services to the new mobile multimedia services is the evolution of technologies that are enabling these new services. Shift from circuit-switched to packet switched infrastructure is currently in progress. Operators are also keen to commercialize the new technology platforms they have invested in.

At the same time we have seen hyper competition in voice call prices, which has lead to decreased revenues, consolidation of players and even exits from Finnish mobile markets. Decreased revenues in turn have lead to cautious and slow investments in new technologies and slow development of new services. As an example Finland was among the last countries to launch 3G-services among West-European countries (Snellman 2005), although Finland was known as a pioneering country for mobile services couple of years back. There are fewer risks taken with developing and launching new services.

However operators are now facing the fact that within few years they possibly cannot charge anything from plain voice calls, so they have to find out sound models how to survive in future.

2. Markets, Market Players and Market Shares

The total value of the mobile services market increased 11 per cent in 2004 up to 247 million euros. All three mobile service categories: P2P messaging, content services and data services grew in 2004. P2P messaging was the largest category by revenue, representing 64% of the total mobile services market value.

Mobile data services showed the strongest growth of the service category in 2004. The market value grew 26 per cent to 21 million euros. Majority of the revenue was

generated by packet switched data services. The value of the content service market was 67 million euros in 2004. Ring tones, directory services and chat services were among the largest services measured by revenue in 2004.

The total value of person to person messaging market was 158 million euros in 2004, representing a 8% increase over 2003. P2P messaging market grew despite the declining average prices per message. The volume growth outpaced the speed of average price decline in 2004. Multimedia messaging did not have a major impact on the total market value and a vast majority of the market value consisted of SMS based P2P messaging.

The installed phase of color display handsets with GPRS, WAP, MMS and Java features represented around one third of the total mobile phone terminals in use in Finland. (Snellman 2005)

Table 1: Mobile service markets 2000-2004 (Me) (Nordic Advicer Group 2005)

	2000	2001	2002	2003	2004
Data	4	7	11	20	26
Content Services	25	41	50	58	68
Messages	121	144	136	148	154
Total	150	193	198	226	248

2.2 Players

Mobile market players consists of various types of actors. These include

- application developers
- applying industries
- component manufacturers
- content owners
- content providers
- end users
- financial services providers
- network equipment manufacturers
- network operators
- and platform developers.

This presentation concentrates to network operators, service operators and virtual operators.

Table 2: Modular product architecture in the Finnish mobile services market (Vesa 2005)

Handset makers	Nokia, Sony Ericsson, Motorola, Samsung, Siemens
Network Operators	Sonera, Radiolinja, Finnet
Service Operators	Sonera, Saunalahti, Radiolinja, MTV3.fi, DNA, Fujitsu, Spinbox, Cubio
Mobile Portals	Sonera MobilePlaza, Zed, MTV3.fi, Club Nokia, buumi
Services&Apps	Sonera Colour, Openbit, MTV3Handy, TrackWell, Eniro
Content Providers	Kauppalehti, Veikkaus, Nordea, Yle, MTV3.fi, FORECA, Nöjesquiden

Despite the small size of the Finnish market there are almost 20 companies in Finland (Vesa 2005) offering mobile phone subscriptions. Traditionally mobile connections have been offered by mobile operators with their own network by so called “network operators”. During the past few years an increasing number of companies started to offer mobile subscriptions as so-called virtual operators or service operators (MVNO) in Finland. These companies do not own the mobile networks they are using. Instead they rent radio network capacity or spectrum from network operators. About MVNOs is discussed later in this paper.

Table 3: Mobile network operators owning licenses in Finland (Vesa 2005)

Technology	Licenses	Licence owners
2G	3	Elisa, Finnet Verkot, TeliaSonera
3G	4	Elisa, (Tele2), TeliaSonera, Finnet

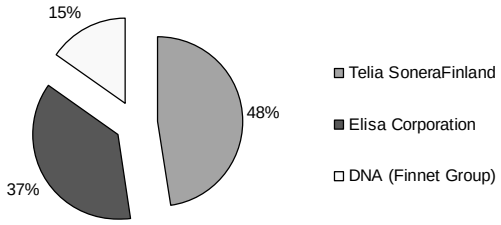
In Finland three operators (Elisa, Suomen 2G and TeliaSonera) have their own mobile GSM networks. Each of them has a separate subsidiary taking care of network operator business, while service operator business is being taken care of by another business unit or subsidiary (Vesa 2005) as regulated by the European commission.

Currently four companies have licence to offer 3G services in Finland. The licences are granted to TeliaSonera, Elisa, Tele2 and Finnet.

2.3 Market Shares

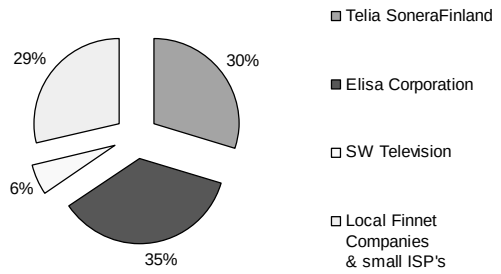
Market shares of mobile subscribers of the major operators by the end of 2005 (Ficora 2006):

- TeliaSonera Finland: 2 507 000
- Elisa: 1 962 000
- DNA(Finnet): 810 000



Broadband access shares by the end of 2005:

- TeliaSoneraFinland: 350 000
- Elisa: 420 500
- SW Television 67 000.
- Local Finnet companies and small ISPs 336500
- Total 1 174 000



3. Influence of Recent Price Competition to the Innovativeness of Operators

One of the most important factor influencing increase in the competition was the introduction of number portability in the beginning of 2005
A total of almost 2,5 million numbers have been ported by the end of June 2005. The number of phone numbers that were ported by 1.1.-31.6.2005 was over 900.000. At the end of June phone numbers ported once was 1215066, twice 441.961, three times 91341 (Korvenmaa 2005). These numbers witness that there has been an intense war for market shares. This has lead to consolidation and even exits from Finnish mobile markets. In 2005 ACN Finland stopped to operate as a mobile provider in Finland. Tele2 announced that it has decided to discontinue its operations in Finland. Elisa bought Saunalahti. Many other players that launched visibility on 2002-2003 have exited or scaled down operations. The excessive price competition had a serious impact for example on TeliaSonera's productivity (Korvenmaa 2005). Similar development can be seen in the results of all mobile operators in Finland.

Finland was 35th country in the world to open commercial UMTS network to public when Sonera (Q3/2004) and Elisa (Q4/2004) opened their UMTS network in the biggest towns.

Mobile services development in Finland has slackened compared to many other countries despite healthy market growth. Although mobile subscriptions volume has grown rapidly the revenues of the operators have not grown. (Korvenmaa 2005)(Vesa 2005).

4. Influence of Consolidation to Price Competition

Regulation changes in the beginning of 2000 brought many completely new kinds of operators to Finnish mobile markets, namely virtual mobile operators. Regulators idea of these operators was to move the price competition and R&D focus from basic voice services to higher level mobile services. It did not succeed. Instead it meant the start of aggressive market share battle which led to excessive price war.

Number portability change by 2003 increased this price competition and customer churn, e.g. the average number of customers that leave a subscription service during the year.

Despite the great number of independent virtual service operators, ACN and Saunalahti had together in 2005 over 90% share of these smaller operators' customers. ACN representing 2% share and Saunalahti 13% share. The total share of other service operators was less than 1%. (Korvenmaa 2005)

In the beginning of 2004 both incumbent operators Elisa and TeliaSonera launched their own so called "cheap operators". Both cheap operators operate in their mother company's networks.

In January 2005, however, in an interesting twist, TeliaSonera Finland, its subsidiary Tele Finland and ACN Communications Finland concluded a co-operation agreement under which ACN Communications Finland discontinued its own branded mobile service and started marketing Tele Finland's mobile service offering through its existing sales channel - Independent Representatives. ACN's Finnish 60,000 customers continued as customers of Tele Finland, though ACN's assets, personnel, agreements or other business operations were not assigned to Tele Finland.

Elisa announced in July 2005 that it will acquire Saunalahti.

After these agreements 90% of MVNOs customer base was transferred back to MNOs customers.

It seems that consolidation has affected the price competition. The price level seems to become established to the level where it was before these movements on markets.

5. Methods to Increase Customer Loyalty

It is not enough for mobile operators to be effective in attracting customers. The operator must be able to keep them and increase their business. We have seen that operators suffer from high customer churn (Korvenmaa 2005). Acquiring new customer can cost many times more than the cost involved in satisfying and retaining current customers.(Kotler 2003)

There are few simple steps that operators can take to reduce the churn. First they must measure their churn. Second they must distinguish the causes of churn and identify those that can be managed better. Third they need to estimate how much profit they loose when they loose customers. Fourth they need to figure out how much it would cost to reduce the churn. Finally nothing beats listening to customers.

Factors that influence mobile users customers loyalty are of course the price of the terminal, price of the subscription, service quality, service portfolio the user is offered and the cost of changing operator.

Price of subscription is not very interesting from the operator's point of view, because competing there leads to price war and price war is not generating revenue. So when thinking of customer loyalty, operator must focus on customer lock by attractive terminal pricing, service quality, service portfolio and cost of changing operator.

One method is of course subscription and terminal bundling. User is being offered seemingly cheap 3G terminal. If user accepts this terminal, at same time he agrees to buy and use a subscription from operator at certain price and use it certain amount of time.

Another way might be to create an interesting pallet of services and bundle them together. These could include 3G terminal, subscription, broadband access and possibly digital TV connection.

Yet another way might be rewarding old customers with discount in subscription fees. It is surprising that operators have not so far used this.

Whatever means to keep customers operators may come up to, they should target customer lock-in so that customers' overall costs of switching operator are substantial. (Shapiro 1999)

6. Influence of 3G Terminal Bundling to Subscription

Finland has been one of the few countries – if not the only country – in Western Europe, where operators have not been allowed to bundle the sales of mobile phone subscription and the handset. This has been seen as a major distraction in the evolution of mobile services. (Vesa, 2005)

Ironically, it has been perfectly legal for operators to attract new customers by giving those DVD players, gift cards, jackets, and so forth but operators have been not allowed to bundle the latest handset model, network access and attractive services.

In the beginning of April 2006 consumers can be offered new technology 3G telephone bundled to mobile subscription. 3G terminal bundling can bring very cheap mobile terminals to stores. Bundling can not be applied to GSM phones.

Operators have been very quiet about their intensions about pricing. How they are going to price the packet? There are some mixed messages on the market. One player does not believe in completely free phones and the other says that in principle completely free terminals are possible (Aamulehti 2006).

However, it seems that operators do want to pay more attention to customer loyalty, quality, and services but at same time they hope moderate competition in the bundling prices. (TeliaSonera 2006)

We have stated that operators' revenues are not going to increase by traditional voice based markets. Also we notice that in data services there can be big potential. When subscription and handset can be bundled, operator can have more control to the service portal user is offered in the screen of mobile terminal. So operator can have better control over the value chain user is offered. What services subscriber is going to use and what content to access? When subscribers use data services that operator offers in terminal portal, this generates more revenue to the operator. From operator's point of view it can be rewarding to try to reach as big market share of an attractive segment of 3G users as possible.

Elisa is already advertising so called Elisa-packet, which is started to be sold 1.4. When user buys a packet, user gets 3G phone and subscription with constant payment per month. The phone is then paid by monthly charges together with subscription payments during two years period.

7. Possibilities for Service Differentiation

Kivisaari and Luukkainen (Kivisaari 2003), state in their representation that mobile services market must not be purely competitive, or else viable pricing possibilities do not exist. That is, if exactly the same information services are offered by various players and the marginal cost of delivery is zero, the fixed costs related to producing the service cannot be recovered. In a purely competitive market some producer will always drop the price even lower until no one can make profitable business or until the one with the greatest tolerance for losses remains as the monopolist service provider. Aggressive competition in mobile prices has witnessed this phenomenon.

In this light the key is differentiation of services. With sufficient level of differentiation in place, content providers should have enough market power to engage in pricing the services according to customers' willingness to pay instead of marginal costs.

Few questions arise. How much lead does the mobile environment have compared to the fixed Internet because the fact that mobile services can be better differentiated using timeliness, personalization and location information as factors of differentiation?

Is the differentiability advantage of mobile networks so great that industry will put the effort to try and build a mobile service network to enforce the creation of new chargeable services?

Today the Internet has a huge lead over mobile services as far as the multitude and diversity of services is considered but the fundamental differentiability of the mobile might contain the momentum to turn this direction.

When we think back the three A's, Anywhere, Anytime, Anything, 3G might indeed offer an advantage over fixed internet. 3G can be seen as an extension of network, which makes it possible to access whatever services whenever, where ever. For example YLE's, TeliaSonera and Nokia's joint project with mobile TV in Helsinki World Championships looked very promising new service (Vesaoja 2005). Mobile TV requires good co-operation from various players.

If we look the differentiating reasons why mobile Internet is not taking off in USA or Europe, we can find that only decisive difference is that neither the United States nor Europe has had a telecommunications provider like DoCoMo with the objective to grow new business and service based on a comprehensive view of the ecosystem as a whole. E.g. content, mobile phones, servers, networks, portals, business model and marketing. If bundling makes 3G phones popular, there might be a change in Finland to success of mobile Internet also.

In the end of 2005 home networking and communication represents already 15% of all household expenditure of disposable income. 40% of homes have broadband connection. 25% own a home theater. 1/3 own a broad screen TV. 2/3 own computer (Korvenmaa 2005). These figures show that there is increasing demand to transfer digital content. If operator's product can be differentiated considering these facts, it surely can be a success.

Whatever path the operators will choose trying to differentiate their service portfolios, McKinsey (Perttunen 2000) offers few guidelines how to success.

- Move quickly. Since high value customers are willing to change operator to get access to wireless data services and scale will be critical in attracting content providers, the first mover will enjoy enormous advantages, while latecomers are likely to suffer. Any operator to provide wireless data services should not delay. This should be thought carefully also when thinking of bundling strategies.

- Be prepared to make big bets in some roles. To succeed as a portal or transaction center, operators need to be willing to commit money and energy. Portals demand efforts to assemble content.

- Build skills in partnership and alliance management. Several roles involve operators in managing partnerships and alliances, so they need to develop strong capabilities in this area.

- Manage regulatory relationships with care. Wireless data raises important new regulatory issues as who owns the information about the mobile terminal's location and whether the operator can (or must) release the terminal's ID to content providers. The decisions a regulator takes on issues like these can have an enormous impact on the value captured by operators.

- Drive consolidation. The roles of gateway platform provider and portal set up cycles of positive reinforcement that lead to increasing returns.

8. The Role of MVNO's

Deregulation of mobile service markets brought in short time period numerous of new and completely new kind of operators. These included mobile virtual network operators, network marketing companies and different kinds of consumer companies brand extensions to mobile subscriptions, like Hesburger's mobile subscription.

The MVNO business model is successful when a company enters the mobile market, and acquires and services specific market segments more cost-effectively and profitably than a mass-market wireless carrier could. To be profitable, MVNOs have to achieve one of the following:

• Increase ARPUs above levels recorded by mobile network operators (MNOs)
• Slash average costs below levels recorded by MNOs
• Both of the above

MVNO has to improve one or more of the following wireless operating metrics to be profitable: CPGA (cost per gross acquisition), CCPU (cash cost per user), ARPU and churn.

The cost per gross acquisition is a key cost element for MNOs. Translated into hundreds of thousands of subscribers, CPGA can represent as much as 30% of a carrier's operating expenses.

The three main lines of cost in CPGA are handset subsidies, channel commissions and marketing expenses. Of these three lines, most MVNOs opt to substantially reduce or entirely forgo handset subsidies; this is an easy measure, especially if the MVNO is targeting a low-end segment, but less so in a high-end market environment. Channel commissions are also targeted, but cost-savings are only meaningful if the MVNO already has an extensive distribution network, or exclusively sells online

Operators in Finland have until now sold SIM-only packages to its distributors. The retailer can add its own handsets, and sell as a bundle. For operators, this has meant no handset subsidization, lower commissions to retailers, and lower subscriber acquisition costs.

Next generation MVNOs will have CPGA levels slightly lower or equal to that of network operators. Owing to their high-end target segment, they'll have to advertise heavily and offer unique handsets. Handset subsidies will be at similarly high levels (if not higher), and marketing expenses will be at similar levels relative to revenue.

It seems that most notable MVNOs strategy in Finland during the price war was to attract as big customer base as possible and to become acquired by MNO. Role of the current MVNOs is very marginal. It remains to be seen if some international MVNO player decides to try to come to Finland and differentiate it's offering by concentrating to develop such content services that current MNOs can not quickly copy.

9. Conclusion

Finland was one of the leading countries in mobile service business few years back. In recent years there has been fierce price competition that has hurt mobile services development in Finland. Now Finnish markets are in turn point. Consolidation has lead to the situation where there are only few "original" players left and nobody seems to be very eager to compete with price anymore. With possibility to bundle 3G phones and subscription there is a change that 3G terminals become common. There continues to be an increasing demand to transfer digital content. If operator's product can be differentiated from fixed internet, there is an opportunity for Finnish mobile service markets to recover from its slump.

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REVIEW OF MOBILE BROWSING TODAY - AND SOLUTIONS FOR THE FUTURE

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Abstract

The aim of this paper is to give a general view of today's mobile browsing. We describe the challenges that relate to the success of mobile browsing and introduce some most important and popular browsing solutions that are currently available.

This article starts with an introduction section which generally describes the history of mobile browsing and discusses about mobile browsing nowadays. Section two explains technologies and standards related to mobile browsing and that section shortly also describes what mobile browser is.

In the section three we present some possibilities for different players of this field and that section is followed by a fourth selection describing success factors for mobile browsing. Finally, we present the most important mobile browser solutions currently available and discuss also about business models that lay under different mobile browsers.

Key Words
Mobile Browser, Mobile Browsing, Micro browser

1. Introduction

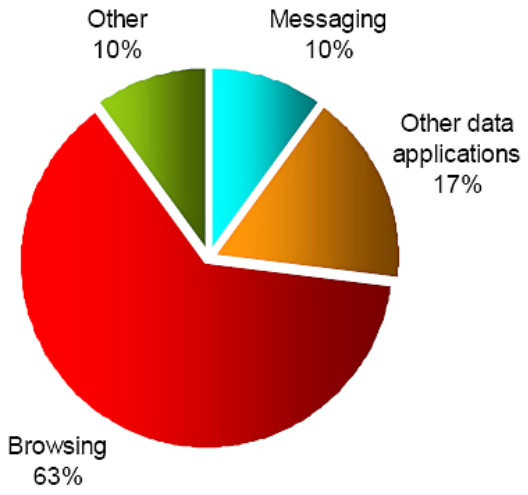
Mobile browsers have evolved greatly from the simple and restricted WAP browsers of the turn of the millennium to the almost PC-like multi-functional browsers of today. While the operators then were advertising the possibilities to access WAP content with mobile phone, nowadays the need is for the whole web on the mobile phone. This evolvement has emphasized mobile device's constraints and their affect to mobile browsing as the web content is mainly designed for desktop computers with lots of computing power and big screens. Developing solutions to solve these limitations has been the main challenge for mobile browser vendors.

Mobile browsing is expected to become very popular among mobile device users. Figure 1 shows results from a resent study with Series 60 mobile phone users. According to this study, mobile browsing created as much as 63 percent of participants' whole packed data usage. Although users participating to the research were technology enthusiastic early adopters, this clearly indicates good success for the mobile browsing in the future as more individuals start to adopt this technology and mobile phones with the functionality needed for mobile browsing.

If mobile browsing in the future is going to be as popular as among these early adopters, then, for operators, data traffic generated by mobile browsing could offer tremendous opportunities to get more revenue. As average revenue per user from voice traffic is constantly declining (Eylert 2005), this data traffic generated by mobile browsing would be a warmly welcomed stimulant for operators' profitability.

This paper discusses about issues that impact mobile browsing and about issues which are in key role to guarantee its success. It introduces the most important challenges for the success and discusses about the key elements that are affecting for mobile browsing to become more popular amongst users.

Figure 1: Distribution of Packet Data Usage by Services (Feller 2005)



2. Technologies and Standards

2.1 What is Mobile Browser

A mobile browser (sometimes micro browser or minibrowser) is a Web browser specially designed for PDA or mobile phones devices. There are four basic limitations for browsers in handheld devices: display, bandwidth, memory, and processing power. Displays are small in handheld devices so browser must effectively display Internet content. Low memory capacity sets limits to features in mobile browsers, and low bandwidth together with low processing power produces limitations to effects displayed in mobile browsers.

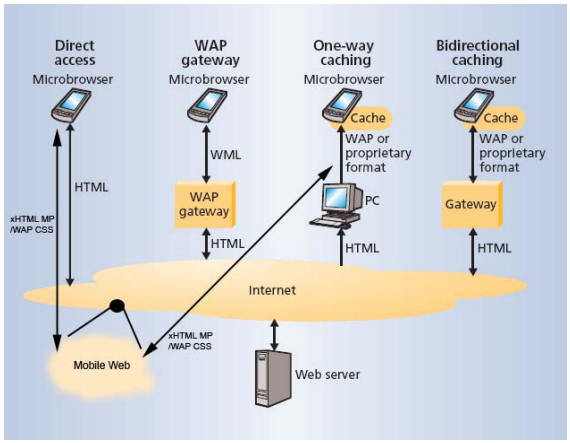
2.2 Browsing the Web and Mobile Web

Mobile browsing can be divided to browsing the Web and browsing the mobile web. The Web meaning general Internet content usually designed for PC-usage and the mobile web consisting of content specially designed for mobile devices. Nowadays there is also a possibility to distinguish mobile web content by the lately (July 2005) announced ".mobi" –suffix (Boston.com 2005).

2.3 Accessing Web content

There are three common ways to access Web via mobile browser. Firstly content can be accessed directly with the mobile browser, secondly content can be accessed through WAP gateway or proxy server and thirdly, content can be browsed offline via device's cache. Figure 2 illustrates different approaches for accessing Web content. (Lawton 2001)

Figure 2: Accessing Web content (modified from Lawton 2001)



2.3.1 Direct Access

Direct access to Web content means that an HTML-enabled mobile browser can access data directly from the Web or alternatively XHTML MP/WML – enabled browser can access data directly from mobile web.

Accessing the whole Web directly via HTML browser requires some computing power from small devices as the content normally designed for PC-usage has to be rendered to fit the small display of the device. Direct HTML access also creates the most amount of data traffic as the whole Web content is first downloaded to the handheld and only after that the content is fitted to handheld's constraints.

In direct access to mobile web, mobile browsers accesses content that is specially designed for mobile browser. This method can also be used in phones with less computing power as the phone has no need to render the content. On the other hand, this method requires special content that is designed for mobile usage or that has been translated to mobile use by content provider. (Lawton 2001, OneUpWeb 2005)

2.3.2 WAP gateways/proxy servers

The second way to access the web is to use a WAP gateway/proxy to first translate HTML Web content to standard WML or xHTML and after that, send the translated data to mobile browser. Accessing the Web content through WAP gateway allows users to browse the whole web i.e. content that is designed mainly for computers. WAP getaway moves the heavy and battery consuming task of rendering Web content from handheld to powerful gateway system. This also reduces the data traffic for the handheld and thus reduces the time to load the content.

Figure 3 explains the situation where HTML content is downloaded from the Web through gateway. Gateway optimizes page code and page graphics for mobile browser's display and also compressed the data before sending it to the handheld. This reduces the size of the content to only 1/3 of the size of the original data. (Lawton 2001, OneUpWeb 2005)

Figure 3: Web content access via gateway (OneUpWeb 2005)

WAP gateways are usually provided by software companies that are also producing mobile browsers but there are also other commercial and open source WAP gateways available. (Kannel, Now Wireless Limited 2004) This allows network operators, other companies or even individuals to set their own WAP gateways.

Google for example uses their own server to translate HTML Web pages "on the fly" to WML when the users clicks on search results. (OneUpWeb 2005)

2.3.3 Caching

In offline browsing, web pages are cached into handheld device's memory for later use. Caching can be done in one-way or in bidirectional way. One-way caching meaning downloading of web pages to handheld's memory for later access and bidirectional caching meaning for example the case where traveling sales representative synchronizes the cache with company server when s/he is visiting at the company's office. (Lawton 2001)

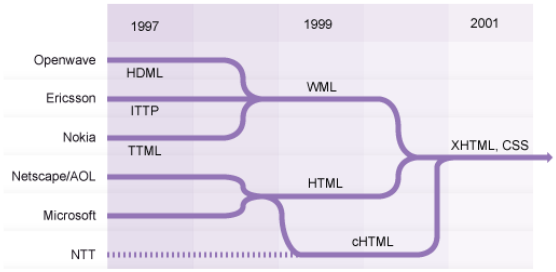
2.4 WAP

Wireless Application Protocol - or simply WAP - is an application environment and a set of communication protocols for wireless devices to enable services equivalent to a Web browsing in mobile devices. It provides manufacturer-, vendor-, and technology-independent markup language and a transport protocol for small device usage. Before WAP was created, some manufacturers already had developed their own application platforms but in 1997 they realized the large business opportunities enabled by one open international standard and gathered together to create WAP. Despite the early hype and exaggerated claims about the possibilities of WAP at the turn of the millennium, nowadays, WAP is in key role to realize mobile browsing and its widening success. (IEC.org)

2.5 Markup Languages for Mobile Browsing

WAP has significantly clarified the history of markup languages for mobile content. Figure 4 illustrates the history of wireless markup languages with several different languages at the beginning and one common language as the result of international agreements. While the Figure 4 illustrates the situation only to the year 2001, situation today follows the path illustrated by the figure. Today WAP 2.0 defines xHTML Mobile Profile (xHTML MP) and WAP CSS as standards for content development. XHTML MP is a subset of xHTML for mobile devices and WAP CSS is a cascading style sheet version supported by xHTML MP. (IEC.org, OneUpWeb 2005)

Figure 4: History of Wireless mark-up languages (Openwave 2006)



Conjointly agreed mark-up language for wireless usage has huge benefits for the industry. For example in 1999 when WAP was using WML and iMode was using cHTML, differences between those languages prevented the mobile web page to be viewed by both WAP and iMode devices. This then meant that content had to be separately written in two languages, which of course was costly for content providers. (IBM 2002) With commonly agreed markup language, this problem has become obsolete.

Mobile browser software providers can nowadays focus on one standard and this of course eases their browser development efforts. Content providers can produce their material in only one standard and thus reduce the cost of supporting several languages. Most importantly, users don't have to be confused with the technicalities related to the content. They don't have to choose their mobile browsers according to content or to have several browsers for different content languages.

3. Possibilities for Different Players

3.1 End user services enabled

OneUpWeb identifies two primary types of mobile shoppers: need-it-now-shoppers and killing-time shoppers. This could also be widened to distinguish two types of mobile browser users. Need-it-now consumers use mobile browsing when they immediately need some service or information. Killing-time users on the other hand use mobile browsing when they are waiting for something, for example buss. They use mobile browser to find information they need in the future, or they use entertainment services just to kill time (OneUpWeb 2005). Consumer users use mostly services like weather, news, and sports.

Mobile browsing makes possible to reach Web content anywhere. This allows users to for example use banking services at their summer cottages. There are also services where user can download e.g. magazine and after downloading view the content anytime in offline state. These kinds of services are especially available in content specific browsers like Nokia Kanavat.

Today there are also more and more services which are based on user location. User could for example search

nearest restaurants, hotels etc. based on their handset location.

3.2 Operators

According to Jan Feller, mobile browsing generates 63% of packet data traffic among early adopters using 3G or GPRS (Feller 2005). This forecast good success for mobile browsing in future. This also means that browsing will be good revenue opportunity for operators.

Change towards mobile web browsing also opens new possibilities, like SIM-card based billing for operators. User can be identified through SIM card and after the use of the third party service operator adds service fee to user's phone bill. For the operator this opens new possibilities to get revenue by taking care of the billing. They can add more and more services to phone bill and capture billing markets from bank industry.

Operators can also brand their own mobile phone and co-operate with mobile browser vendor to set operator's own Web page as the home page for the installed browser. By this operators can effectively affect to user's mobile browsing.

3.3 Device Manufacturers

Nokia's closed content media browser called Nokia Kanavat (discussed in 5.2.) is a good example of how mobile phone vendor could take advantage of mobile browsing. Nokia's own media browser involves all Finland's biggest mediums to create large amount of content available for consumers. Nokia includes this Kanavat browser in new mobile phone selling packets so it's easily available (Franck 2005). This is example how device manufacturer makes more value to their core products by providing content for consumers.

4. Success Factors

Key success factors for mobile browsing include price, content, usability and bandwidth.

4.1 Content

While the amount of mobile web content varies between countries (Roto), people in countries with only few mobile web pages are still using their mobile devices to access HTML Web content. As more and more browsers become capable of showing also HTML content, there should not be lack of content available considering the vast amount of Web pages in the Internet. When people start using their mobile browsers to access the Web, content providers might also see the increasing mobile browser usage as a signal to profitably create mobile web content.

4.2 Price

The overall price of mobile browsing consists of traffic tariff and content price. When user browses the Web content that is freely available, costs of browsing consists only from traffic tariffs.

Browsing of content with a price tag should be made easy for the user or s/he will frustrate and end browsing. The ease of browsing priced content is derived from the ease of the payment and the easy access for paid content. This has been considered at least in content specific browsers like Nokia Kanavat (discussed in 5.2.).

The best way to price traffic would be flat rate pricing. Pricing by the bits transferred limits browsing for example because Web content generally includes several advertisement pictures from which the user is not willing to pay extra. If the user then restricts the browser from downloading pictures, s/he will also lose pictures that are vital part of the content. This then further differentiates the mobile browsing from desktop browsing thus negatively influencing the mobile browsing experience.

4.3 Usability

According to Roto, mobile browsing usability consists of three usability layers but for the user, mobile browsing is holistic experience i.e. user sees only the usability of the whole browsing experience. Figure 5 illustrates this usability experience (Roto).

Figure 5: Three layers, but holistic usability (Roto)

From the user's point of view the mobile browser should function smoothly with all types of content, whether it is designed for mobile device or PC. This causes problems especially with Web content which is not designed for small screens of mobile devices. The mobile browser with most usable solution for browsing is likely to gain success. Mobile browser developers have developed several different solutions to overcome this most visual usability problem. Most common solution today is to display Web content in narrow layout, which removes the need to scroll pages in

horizontal direction. However, this solution is not totally problematic.

According to Roto, users face problems as the first page they see in narrow layout usually contains list of links that in PC environment is displayed for example at the left frame of the web page. Now, as the user clicks on one of the links at the top of the page, s/he ends up seeing the same link list also at the top of the downloaded page. For the user this seems like nothing has happened and they might try to select the same link again. Users don't notice that they would have to scroll down the page to see the updated content. This causes frustration amongst users and there are evidences that users may even quit browsing at this point.

Lately introduced Minimap solution tries to ease some of these kinds of usability problems that have been found problematic with narrow layouts. In Minimap solution, users first see only a miniature version of the whole web page. Then it is easy to use a square provided to select a part of the page for closer examination. This miniature version of the web page is very fast and efficient way to browse long web pages that would be extremely slow to browse in narrow layout.

Another issue related to usability is the size of the device's screen. We believe that during the evolution of mobile phones, device manufacturers have already tried out and examined several possibilities for display size and that for the largest consumer segment there are no possibilities to further increase the display size without loosing the value that comes from the small size of the device. There are some market segments, like business users that might accept bigger screens for better visual experience, but the size of this segment is limited. In addition, we believe that with currently acceptable display sizes, it is not possible to largely increase the number of pixels without affecting the readability of the content. Because of these limitations related to displays, we believe that usability problems have to be solved by some other means.

4.4 Bandwidth

Low bandwidth and mobile content limitations related to bandwidth requirements were probably one of the reasons why WAP failed at its early stages. Although more bandwidth always means nicer browsing experience, today, mobile devices with EDGE connection can already reach data rates up to 384 kbps. Considering PC modems with only 56 kbps connection speed and the lightweight mobile web content, mobile browsing should be at acceptable level already with current bandwidth possibilities.

5. Solutions and business strategies

5.1 Current Solutions and strategies

First mobile browser solution was a browser called HitcHiker. It was developed by a British company STNC and introduced in the year 1998. (TechWeb 1998)

It is reasonable divide current mobile browser vendor strategies to two categories. First category contains default browsers used by major mobile phone and PDA vendors. Second category consists of user-installable mobile browsers. Series 60 Browser and Pocket Internet Explorer represent the first category and Opera and Opera mini are examples of the second category. Opera also has co-operation with handset vendors to bundle browsers already into new mobile phone sales package.

Opera
Opera by Opera Software is one of the most popular solutions to mobile browsing in the market. Opera's latest version 8.5 supports all current standards like CSS2, Javascript, Ajax, WML, and XHTML. (Osnews.com 2006)

Opera obtains Web content directly to the device, but then there is a small screen rendering (SSR) mode in the browser which renders Web content to fit into narrow layout which requires no horizontal scrolling. This makes it possible to mobile browse sites that are designed to desktop displays. The technology under SSR is proprietary but web site designer can affect how page will appear in SSR display by using CSS. Opera is effective solution to mobile browsing but it also needs quite lot RAM so it's mostly used in PDA or smart phone devices. Opera is a commercial solution and user has to pay a license fee if s/he wants to obtain the browser.

Opera mini
Opera mini was officially launched in January 2006 (Gohring 2006). It is specially designed for low- and mid-end handheld devices which normally are incapable to display normal Web content. While browsing, Opera mini doesn't require the phone to process web page. Instead it communicates with Opera's proxy servers which re-process the page before sending it to phone (as discussed in 2.3.2). This re-process strips down the size of content and makes browsing faster.

Opera mini is available for free and users can download it from the company's web site. Opera offers also branded and customized versions of Opera mini for operators and content providers to get license fees from the product. In addition to this, the company has also launched co-operation with Google in December 2005 (InformationWeek 2006). This agreement brings Google as default search function for Opera mini.

Series 60 Browser
Series 60 browser is a standard component of Symbian S60 platform. Like Opera browser, this obtains Web content directly to the device. It is based on open source components (Webcore and JavaScriptCore). This browser is created in co-operation with Apple and these same open source components have been used in Apple's Safari Internet browser. These Webcore and JavaScriptCore components are based on KDE's Konqueror open source project (S60.com).

Series 60 browser supports all important standards related to mobile browsing, like HTML 4.01, XHTML 1.0, CSS 1, 2, 3 (partially), and DOM 1&2. Main innovation in the new, lately announced series 60 browser is the Minimap feature (Osnews.com 2006). This feature allows user to see the minimized version of the whole web page in small display. User can then easily navigate the page and select the area they wish to view in more detail.

Pocket Internet Explorer
Pocket Internet Explorer is the default mobile browser in Windows mobile operating system. It requires 504 KB ROM for rendering and 2.2 MB for all components. In comparison with desktop Internet Explorer 6.0 which requires minimum 15 MB ROM memory. (MSDN Home 2006)

5.2 New Business Models

There is also continuous searching of new business models in this mobile browser section. With the browsers introduced in previous section, user is free to browse all content available in Web. Besides these open browser models, currently there are also browsers available which can be used to browse only limited content. One of these browsers using this interesting new business idea is Nokia's new Nokia Kanavat multimedia browser.

Nokia launched this new browser at 28.11.2005 for Finland's mobile market (Franck 2005). Idea of this Nokia Kanavat is to get Finland's media services into mobile phones. User can only browse content that is specially designed to Kanavat browser. Since the beginning, all Finland's main TV channels like MTV3 and YLE and newspapers like Helsingin Sanomat and Kauppalehti have been producing content to Kanavat media browser. Nokia Kanavat media browser is currently available only in Finland; however, in the future there could also be Nokia's media browser launches in other countries as well.

Content providers can automatically generate content to Kanavat from the same source data they are using to create content for newspapers and HTML Web. They can automatically translate HTML Web content also to format suitable for mobile browsers. This, of course eases content providers task as providing content to Kanavat requires no extra working effort.

Browser is available for free via Nokia's Web site. Nokia also includes this Kanavat browser in new mobile phone packets. In first phase, the content user downloads via Nokia Kanavat is free and users pay only what their operators charge from data connection. Later on, the content is changing to partially commercial, and the idea is that user can for example pay and download magazine. After downloading the magazine user can browse it offline anytime s/he wants.

6. Conclusions

Mobile browser industry is currently moving from disorder situation with many different standards, technologies and vendors towards the times with fewer players dominating the vast majority of the field. However, due to several mobile phone operating systems, we do not expect for only one mobile browser to reach dominant position with as giant market share as Internet Explorer has in desktop browser markets. A difference in mobile device hardware designs is also a reason, why there will be market possibilities for mobile browsers like Opera and Opera Mini, which are targeted for devices with different capabilities.

Mobile Browsing seems to be moving from technology early adopters towards early majority of the population. According to Forrester Research survey of 65 000 U.S. households, 15 percent of mobile services subscribers accessed the Internet from their devices in 2005. This 15 percentage of individuals already starts to reach the 16 percent mark after which individuals adopting new innovation belong to early majority. (Rogers) In Finland the percentage of users accessing the Internet via mobile devices might be a little smaller as the resent study ordered by Elisa anticipated that only six percent of 3G mobile users accessed Internet with their 3G devices. (Kauppalehti 2006) When the early majority of individuals start to adopt the mobile browsing it is likely that content providers also start to become more interested in mobile web content and this again may increase the number of mobile browser users.

The best vendor strategy for mobile browser software is to pre-install it into the device and that way automatically distribute the mobile browser in the mobile device's sales package. This allows easy and fast mobile browsing experiences for the user and therefore increases the success of mobile browsing. Today, only small minority of users downloads and installs software from the Web to their mobile devices.

Content limited mobile browsers like Nokia Kanavat will likely become widely adopted by users. Ease of use related to Nokia Kanavat browser and its easy content payment possibilities are likely to increase its success among consumers and content providers. However, as users probably also like to access Web content, there is also room for open content mobile browser in devices with content limited browsers.

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DIGITAL RIGHTS MANAGEMENT IN THE MOBILE ENVIRONMENT

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Keywords: Mobile multimedia, Digital Rights Management, Business model, Dominant design, Superdistribution.

Abstract: Number of Internet capable mobile phones is growing with rapid space. However, the data consumption is still very low in the mobile community. The existing business models for sharing mobile multimedia have not worked properly, and new solutions are looked for. In the mobile environment Digital Rights Management (DRM) is a key enabler for novel business models like Superdistribution, a Peer-to-Peer (P2P) type of Consumer-to-Consumer (C2C) delivery chain. DRM is a concept that defines the access rights to the copyrighted digital media. It does not only include encryption technologies but the whole architecture, content formats, commerce and usage monitoring. In this paper we evaluate novel business models supported by the latest mobile DRM specifications, and we give recommendations how they should be applied to the mobile environment in order to create a healthy business opportunity for all players in the industry.

1 INTRODUCTION

Mobile phones are becoming more and more suitable for digital content consumption such as games, music and video content. Typically a virtual network of complementary products that share a common technical platform accelerates innovation diffusion because larger availability of complementary components increases their counterparts' value (Shapiro and Varian, 1999). Smart phones include currently Internet browsers, cameras, audio and video players, FM-radios, a large memory space, high quality stereo sound and reasonable screen size. Parallel, high speed mobile data communication networks, both wide and local area, are starting their commercial evolution.

Basically mobile phones could replace the position of stand alone digital cameras and music players, thus mobile phones have the advantage that end users prefer to carry just a single device while being also all the time reachable (Eylert, 2005). Mobile digital content download enables consumers to experience events that inspire instant purchasing actions. The mobile service can facilitate the link between the experience and the download event, thus stimulating unplanned purchases on the move (Grech and Luukkainen, 2005).

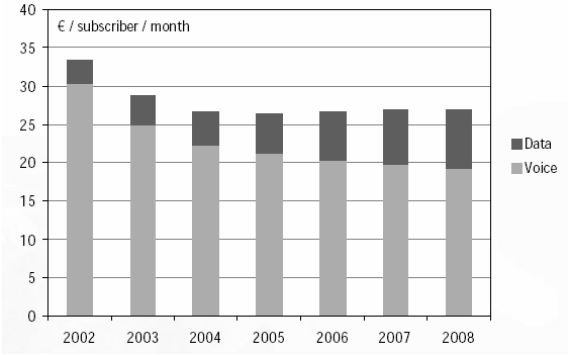

Figure 1: ARPU forecast for mobile services (Forum Nokia, 2004).

Mobiles will be capable both to consume branded content and also to publish user created content. From the mobile operators' point of view content business is extremely important because the Average

Revenue per User (ARPU) figures have lately come down because of the fierce price competition related to basic voice and SMS services in GSM networks as shown in Fig. 1 (Forum Nokia, 2004). There is however a contradiction in price per transferred bit between voice/SMS services and new digital media formats. That is why operators should be able to apply content based pricing schemes in their mobile Internet business. Important requirement is also to separate the control of content consumption from the content delivery (Kivisaari and Luukkainen, 2003).

Lately, the operator independent Internet service innovations have been receiving more foothold and started to disrupt incumbent operators' business models. Disruption refers to a situation where previous technology improves established products and services along the dimensions of performance trajectory that the existing customers value. This technology trajectory can finally exceed even most demanding customers' real needs while the mainstream market becomes highly commoditized. Parallel discontinuous technological change, ignored by the incumbents, may enable cost effective products that initially attract cost sensitive low-end customers. If new technologies quickly diffuse to the markets, new entrants can gain volume related advantages if they are also able to attract customers in the mainstream market (Christensen, 1997).

For example, Amazon, Skype, eBay, Yahoo and Apple have been successful to utilize novel business models that suit for a new economy. Surely a long list of companies has failed and even bigger group of enterprises is currently looking for the new ways to keep their business profitable. On the other hand, most of the Internet traffic belongs to the Peer-to-Peer (P2P) category, that is outside of the business ecosystem due to lack of an appropriate copyright system. Mobile businesses can learn a lot from the Internet experiences, but it should be noticed that the Internet success stories should not be applied directly due to the different usage models and constraints in the mobile networks and terminals.

Management of the Intellectual Property is the key phrase for a successful content business. Digital Rights Management (DRM) has been the de facto solution to protect content creators' and owners' immaterial rights. DRM is a process that defines the access rights to the copyrighted digital media. It does not only include encryption technologies but the whole architecture, content formats, commerce and usage monitoring, which makes DRM an organic part of the business model.

Highly modularized standards would increase the flexibility to adapt uncertain market needs by providing a larger field of options from which to select and allowing market selection of the best outcomes. Standards should be introduced in an evolutionary way by starting from a simple one and building the complexity as market uncertainty decreases thus allowing for a staged investment in creating and growing the standard (Gaynor, 2001). Typically new technology and related standards do not become common in their initial form and dominant design is not based on the leading edge of the technology. As DRM standard contains large set of optional features, the biggest challenge lies in the creation of dominant design that contains a set of features that best meet the requirements of the early majority of the markets. As a result of this a critical mass of users could be created and associated technologies would start to benefit about network externalities (Shapiro and Varian, 1999).

On the other hand, it is essential to that we should maximize the value, and not the protection. This emphasizes certain requirements of a DRM system: a very high of usability and freedom together with sufficient content control mechanisms. According to theory high price leads to low quantity. By a good business model we are however able to set the price that maximizes the revenue (Baseline case). More liberal terms and conditions increase the value of the service to the customer, which shifts the demand curve parallel when also copying and sharing increase which further also decrease quantity. A sustained business model seeks the optimal solution between these forces (Fig. 2). (Shapiro and Varian, 1999)

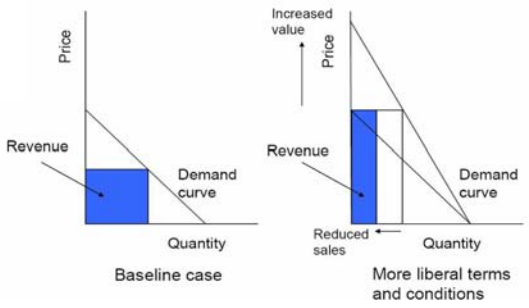

Figure 2: Demand Curve, Quantity and Price (Shapiro and Varian, 1999).

The mobile environment is most suitable for legal and reliable content distribution. Unlike P2P networks, the mobile users form an authenticated community, which enables a coherent market place and channel. More than 2 billion mobile phones, with a rapidly growing penetration of smart phones,

are ideal devices for music, picture, video and other digital content consumption, and surely mobile phones interest any content creator as a new distribution channel. In addition to the traditional client-server business models, Consumer-to-Consumer (C2C) trading is becoming realistic. This new business model has also been called Superdistribution. It means free C2C distribution where content is usually protected from modifications and usage requires a separate license.

The scope of this paper is in the mobile branded content. As a research method we first study the existing Internet business models and draw from these experiences the requirements for the mobile industry. DRM basics are shortly presented. Open Mobile Alliance (OMA) has specified a set of new mobile DRM specifications, and those will be reviewed. Novel business models suited for the mobile markets and the DRM systems are then evaluated, and we give recommendations how to apply these specifications to implementations and successful business models.

2 EXPERIENCES FROM THE INTERNET

Only a small number of ecommerce sites in the Internet has been successful. This is not very surprising because the history of the Internet is very young and the old laws will not hold in the new economy. However, it is a worth of study what have been the factors behind those who have succeeded, and what the mobile domain might learn of those experiences. It is evident that there is no one success method but a collection of versatile models that can be combined. In the mobile history several mistakes have been made and we may learn a lot of those, too. In the following sections some of the key factors are discussed.

2.1 The Long Tail

In the famous Wired magazine article (Anderson, 2005) a new term the Long Tail was presented. It highlighted the importance of the tail of the typical Zipf-like consumption distribution, such as the one illustrated in Fig. 3 (Castro et al., 2005). The key point here is that although a rather small number of unique items receive more hits than others in average, the impact of the Long Tail in the total volume is higher. That is why it is extremely important the content downloading service is not restricted for a narrow, most popular category but the service must allow access to the niche markets, too. Regarding to the DRM policy it can be assumed that typically the mass market must be well protected, while the Long Tail material with less downloads might benefit from a lighter protection.

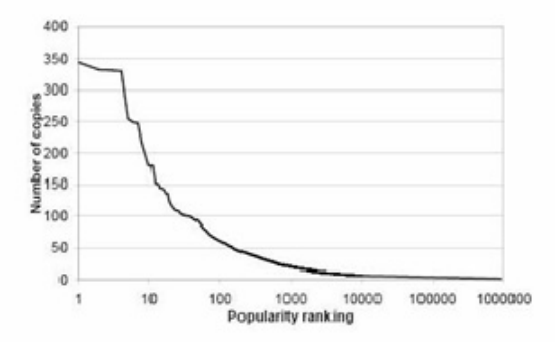

Figure 3: The Long Tail in eDonkey (Castro et al., 2005).

2.2 Music distribution

Music industry has found that the Internet is most suitable channel for music distribution. Basically all examples presented are also valid on the mobile side. Usually Internet music distribution sites utilize advertising, free access and samples to attract customers in. Subscription is not normally required but for a frequent user it will create substantial advantages, for example users may get rid of advertising and have additional services. For the enterprises user registrations are an important asset because that information can be used in the pricing of the advertisement space and planning of own product portfolio. It has been estimated that the value of each registration can be tens of dollars, when the company value is evaluated, for example for the Initial Public Offering (IPO).

Apple's iTunes will most probably follow the Zipf-distribution, too. They have now sold over 1 billion records from a selection of 2 million unique copies. In average this makes 500 copies each. The business model of iTunes is the most restrictive. The proprietary DRM solution, called FairPlay protects the value chain from end-to-end allowing iTunes's Advanced Audio Coding (AAC) records to be played only by the Apple's iPod players. CDs can be burned without limits but records can be copied just to five other hard disks. Pricing is based on the pay-per-use model with a slightly lower price level than in the usual shops. As an advantage users may just

download individual hit songs, instead of full albums.

MusicMatch is a similar service to iTunes but it has one interesting new feature. It learns from the customer downloads and can recommend new songs fitting to the previous genre. Furthermore the service can set up a personalized radio station by randomly streaming songs according to user's preferences. Favourite lists can be shared with friends which strengthens the community aspect. Wippit has a different business model. They are offering a subscription based unlimited access to the record collection of 60 000 items that are continuously updated. Some of the MP3s are not protected at all and they can be freely copied, while others are protected with Windows Media DRM. A wider selection is available through a pay-per-use policy. A compensation based business model is also common. Most often the business logic is based on the advertisements, that must be received for a free content. Qtrax is an example of this business model. Weed service supports rewarding in the C2C model. In this case, both the music aggregator and the private distributors are rewarded when music is distributed through the C2C interface.

2.3 Peer-to-Peer

P2P traffic conquers already the major stake of the Internet trunk lines and in the access networks more than 90 percent of data traffic is from P2P applications. The success of the P2P applications has proved a few important lessons. First, consumers are willing to share content if they have a proper incentive to do so. Otherwise the Free Riding problem occurs which means that users just download content, without the sharing principle of reciprocity (Kwok et al., 2002). In most P2P applications, rewarding is reversed to the punishment, e.g. you are not allowed to download if you do not simultaneously share.

Second, P2P sharing technology works well without the help of the centralized servers and operators. Unfortunately for the content owners, P2P does not usually include the business possibility. In any case, the Internet P2P applications have shown that P2P is an extremely efficient content sharing method, and C2C communication channel can be used efficiently in the viral marketing. These ideas should be taken into use in the mobile networks, too. Even in the mobile environment P2P can be a competitive distribution method (Kumar and Hammainen, 2005).

2.4 Copyright risks

It has been claimed that copyright can be the worst enemy of the artist, though it should be totally opposite (Fisher, 2004) It is clear that content creators must get compensation for their work but sometimes copyright rules are just preventing content distribution and thus opportunities for new income. Recently there have been several cases on the newspapers that have not favoured the copyright acts.

The most famous example was the Sony root kit that was added to the CDs to prevent coping. As a side-effect the added software caused vulnerabilities to the PC security. A second example concerns the Finnish mobile TV plan that met a surprising drawback. Copyright organizations want new royalties from the TV broadcasters based on the claim that the mobile TV is a new distribution channel and each channel has its own fees. As the third case we may mention Habbo Hotel. It is children's virtual community game, that cannot utilize music sharing due to the high copyright fees.

A lighter licensing system such as Creative Commons (Creative Commons, 2006) offers an alternative copyright model, or with better words, a copyleft act. Creative Commons license suits well for the user created content that does not require strict copyright rules. Content creators can for example just require that the original composer is always mentioned but otherwise the artistic piece can be borrowed as wished. The usage of Creative Commons does not automatically mean that the sales of the goods will drop. The book by Lawrence Lessig (Lessig, 2005) has sold more than 200 000 copies, though it is freely available in the Internet. A few days after the book was published in the Internet, it was translated by the community to several other languages, even for the blind. The lesson here is that free copies in supporting frameworks can promote the sales of the actual product.

2.5 Mobile experiences

The history of the mobile industry has not been successful with the content distribution. Cellular operators are facing a contradictory situation where they on the other hand should encourage users to increase the data usage but then again most of them try to continue the Walled Garden approach. It is typical that operators are afraid to loose their control to the Internet services. WAP was an excellent example of this thinking with well known end

results. WAP neglected the meaning of the Long Tail by providing access only to the operator selected material. Also the revenue sharing model was not acceptable for the content providers.

A slightly different approach was taken in Japan where DoCoMo's iMode service offered users and content creators more freedom and especially more profit. However, the market situation was different because DoCoMo was controlling the whole value chain. In mobile world compensation model has also been utilized successfully. There are a few new success stories, too. In China, Tom Online content portal (Godfrey, 2006) has created highly popular and profitable mobile ring tone business using, for example, free music content as a promotional tool.

Another challenge for the data innovations has been the SMS trap. SMS has been dominant design and most of the new services have been tailored to the SMS infrastructure. SMS advantages are that it is widely deployed and interoperable, but at the same time it is also very limited in features. The success of SMS has been an obstacle for new service innovations. For example, mobile email and instant messaging have not got too much support from the incumbent operator due to the fear of cannibalization and disruption of SMS revenues.

3 DIGITAL RIGHTS MANAGEMENT

The traditional information security functions, such as confidentiality, integrity, authentication, anti piracy protection, access control, non repudiation and availability, must be solved before a content business can be started. DRM can solve most of these challenges, except availability that is threatened by Denial of Service (DoS) attacks. DRM architecture includes three components: Content, Users and Rights (Iannella, 2001). Content refers to the intellectual property, Users can be anybody in the delivery chain, from content creators to final consumers, and Rights define the permissions, constrains and obligations between the content and the user. DRM utilizes several technologies to provide the information security services. It is a typical misunderstanding that DRM equals only to the encryption of the content.

Digital Signatures guarantee that content is not forged and thus also non-repudiation. Digital Watermarking and Fingerprinting are used for copy control, distribution tracking and usage follow-up (Hartung and Ramme, 2000). The idea is that watermark is added to the content before possible encryption and it is difficult to notice or forged. In some DRM solutions a separate metadata file is added to the content to define the interactions between the content, user and rights (Davis and Sarvas, 2004). Special markup languages are used to create the files. Finally, security protocols are utilized for secure transport, access control and authentication. (Dixit and Wu, 2004, chap. 11)

3.1 OMA MOBILE DRM

The Open Mobile Alliance (OMA) was founded in June 2002 to develop and promote open standards and specifications for the mobile world. Already on September 2002 the OMA DRM 1.0 specification was approved. It provided the basic features to protect the content, namely ring tones and MMS messages. The extended specification, OMA DRM 2.0 was approved on March 2006.

OMA DRM 2.0 enables a large set of different distribution mechanisms. Content can be delivered through Pull, Push, Push initiated Pull, broadcast, multicast and Superdistribution methods. Super-distribution is backed by the Transaction tracking feature that enables free and controlled content diffusion in a C2C manner. Delivered items can be stored for backup purposes and used later. Also Unconnected devices are supported meaning that content can be transferred to devices that do not have Internet connection. Specification also includes an Export function that enables OMA DRM protected content to be opened in non OMA DRM device. Streaming is supported both by unicast and multicast delivery methods. Finally, the Rights Object Acquisition Protocol (ROAP) takes care of the interactions between the entities in the architecture, described in Fig. 4. (OMA, 2006)

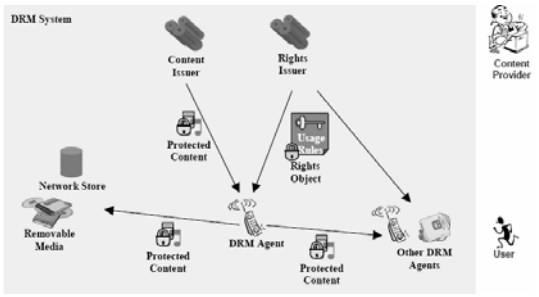

Figure 4: OMA Architecture (OMA, 2006).

Watermarking is not part of the OMA DRM 2.0 specifications, but it is left for the implementation

(Trimeche and Chebil, 2004). Optional features are also Streaming, Superdistribution, Unconnected device and Export function. Optional and loosely defined specifications unavoidably inherit interoperability problems. It can be expected that the dominant design will also emerge in the mobile DRM markets to overcome these obstacles.

Currently the world DRM markets are very fragmented (Rosenblatt, 2006), but it can be anticipated that in addition to the OMA track, Microsoft Media DRM and iTunes technology will play significant role in the mobile markets, too. At the moment there is no exact information how widely and fast OMA DRM 2.0 will be deployed in the smart phone markets. According to an analyst report (DTC, 2005) number of smart phones will exceed 300 million by year 2009. It can be assumed that these phones will support OMA DRM 2.0 specification.

4 BUSINESS MODELS

There is a huge selection of different business models that can be utilized in the mobile domain. Most of them are familiar from the Internet but the OMA DRM specification enables also new ideas.

4.1 Alternatives

Based on the delivery method, models can be split to client-server and P2P types. In the first one content is shared from a central server, while in the second option content is stored and forwarded directly from the end nodes or peers. Multicast and broadcast distribution technologies offer the third alternative. (Dixit and Wu, 2004, chap. 11)

Depending on the DRM system in use, content can be offered in various ways. The most popular business models include subscription and pay-per-view, -use or -download. Subscription based model enables access to the predefined library of content. It provides a simple charging logic, both to the user and service provider. Relating to the previous a promotional model splits the content to classes. A user can select the appropriate class explicitly or she or he will be upgraded automatically to the most suitable class. Pay-per-view, -use or -download methods charge users separately on each transaction. On frequent and small purchases this solution creates a lot of charging data and can discourage consumers to use the service.

Micropayment is a special version of the pay-per-view. Idea is that content downloading can be defined in great accuracy, for example based on the URL address, and each action would be charged individually. It is clear that this system would be heavy and complicate, and vulnerable to dynamic changes. Mobile operators have a good competence on collecting small payments. However, the current law in several countries prohibits them to charge any other services than those directly related to their own business. If operators start to expand offering charging services to any other businesses, they must comply the banking laws.

Streaming enables also Rental service that could be applied for the video-on-demand service (Helberger et al., 2004). However, knowing the high processing requirements of the live streams and on the other hand the battery limitations of the portable devices, streaming does not seem to offer a viable business model in the mobile environment.

4.2 Superdistribution

C2C trading, such as P2P and Superdistribution, will improve the system scalability, and more importantly it creates the community aspect. Superdistribution partly overlaps with the previous business models, but provides also new possibilities. The most interesting possibilities include gifting and rewarding.

Idea in gifting is that the user can recommend content for a certain number of her or his friends who are not members of the service. They have a chance to use the content for a restricted time and after the expiry of the trial period they are offered a membership. Gifting acts here as a strong marketing scheme and suits well for the face to face type of cellular communities. Incentive for the Superdistribution can be enforced by rewarding. The idea is to motivate the content sharing by giving a small compensation to the distributor on each chargeable C2C delivery. Rewarding is an important tool for the birth of the viral marketing business (Einhorn and Rosenblatt, 2005).

Compensation model can be also used in the Superdistribution context. DRM protected advertisement files can be attached permanently to the original content files, and when content is played and advertisements shown, user statistics are sent to the centralized system. Distributor can charge the advertisers based on the number of hits. Compensation can be deployed also in other ways as mentioned earlier. Content distributor can give free

teasers for the community network, and later they may initiate new client-server type of business.

4.3 Recommendations

OMA DRM 2.0 enables almost any business model. You may choose models that are closed or open, complicate or simple, slow or fast, more or less secure. It is up to the manufacturers, operators and content creators which of the selections maximize profits for the whole value chain. As a drawback, the high flexibility incorporates a high risk to interoperability problems. To avoid those, operators and manufacturers must clearly agree the mandatory features supported.

Based on our analysis and evidence from the fixed Internet, Superdistribution functionality, with gifting and rewarding options, is a mandatory new feature to be supported in the mobile phones and presumable dominant design. It clearly underlines the social behaviour pattern common among humans. Viral marketing and different kind of compensation based business models are becoming fascinating. Rewarding is also supported by other research results (Kwok et al., 2002). However, the system implementations should respect the privacy rules, and the tracking features should not be used for collecting personal profile information without users' permission.

Inter-operability to the major, dominant Internet DRM systems will also be important due to the weak network externalities of the mobile DRM systems in the beginning. This means that mobiles should support also de-facto DRM standards and it should be possible to share OMA DRM protected content to non compatible devices, too. Unconnected device and streaming options do not probably have too many use cases and could be considered to be left out of scope.

The Long Tail impact should be taken seriously. It is not enough that only the mass market demands are satisfied (Anderson, 2004). Consumers prefer free possibility of choice, and Walled Garden approach should be forgotten. Mobile operators must offer versatile content selections with competitive prices compared to the downloading over the fixed Internet or WLAN. This means that both the distribution and content itself cannot be over priced. Otherwise the content will be downloaded over the fixed Internet using flat rate tariffs and copied to the mobile phone with a playback capability. If the price difference between fixed and mobile connections is too high, users will not have a high motivation for wireless downloading. Operators must consider flat fee type of data transmission packages in addition to content based pricing to eliminate the contradiction between customer value and cost of the content. Take example of the Wippit service, subscription based business model could be used, at least, for part of the mobile content.

The threat from the P2P networks is not that big as anticipated. The success of iTunes has shown that people are ready to pay if the price is on acceptable level. It could be claimed that the best way to avoid the piracy is to make it obsolete by providing a better, legal alternative. DRM has, however, only limited possibilities to stop piracy (Fetscherin, 2003). The DRM solution is always a compromise of the usability and the protection level, and the small minority should not drive the decisions made for the majority. More flexible copyright licensing terms, such as Creative Commons, should be carefully considered to be utilized for certain content. Especially with niche markets belonging to the Long Tail, strict copyright rules are questionable.

Mobile community should have also learnt something from the past. Innovation must be the main goal or otherwise the fixed Internet will stay years ahead in the innovation cycle. It is time to compete with new and useful services, and not only with price. Mobile sector must take a fresh look at the new possibilities and business models.

5 CONCLUSIONS

This paper has discussed the issues impacting on the mobile DRM and the related business models. The scope was in the commercial content but the user created content should not be forgotten either. The Internet services give valuable background information for the successful mobile DRM solution. OMA DRM 2.0 offers a wide tool box to implement different business models. Superdistribution is an interesting possibility for the mobile phones to be utilized and studied further. DRM solutions should be optimized to meet the benefits of all players, including the non mobile users. The best results do not necessarily equal to the maximal protection but in several cases a more open approach gives the best output.

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E-COMMERCE, ELECTRONIC PAYMENTS

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Abstract

E-commerce concept has changed a way of doing business in a modern world. It is not just electronic payment on the Internet. There are several application areas in this category; like banking activities, publishing including electronic distribution, sales portals covering sales, marketing, production, management, and distribution. For example one is able to buy an airline ticket, download music or a book just by giving a credit card number and click download button in a webpage, do bid in auction for merchandise. And what's best, you have a 24/7 availability worldwide markets and machines are tireless unlike humans.
When enabling these kind of services, protection of a individual privacy, computer security and application technology is are key issues. If security issues are challenged by the users it also means that there will not be users for the services. There are several technologies available for these growing markets saving companies for marketing storage and logistics cost.

Introduction

The subject of this report is to introduce some e-commerce related issues like technologies, societal and economical issues.
From technological perspective there are issues like network solution, security and data communication standards graphical user interfaces, multimedia technology ,data security related like Internet payments and banking. Development of a mobile phone, PDA's and roaming technology enables usage of the e-commerce services independent of location.

1. e-Commerce

Word e-commerce (electronic commerce) refers to a variety of different online business activities for products and/or services. Business transactions might include ordering, selecting goods, invoicing and payment. They may also involve the agreement of contracts, the arrangement of the arrangement of delivery, the declaration of tax and after sales service.
Key word in eCommerce is that business is done without any physical exchanges or direct physical contact.
Usually the link between supplier and a customer is computers on the internet, but it might also be a private network. Nowadays end user terminal can be any kind of PDA or cellular phone which has a network capabilities.

2. e-Commerce types

Major types of e-commerce can be categorized:

- Business to- Consumer (B2C)
- Business-to-Business (B2B)
- Consumer-to-Consumer (C2C)
- Business-to-Government (B2G)
- Mobile commerce (m-commerce)

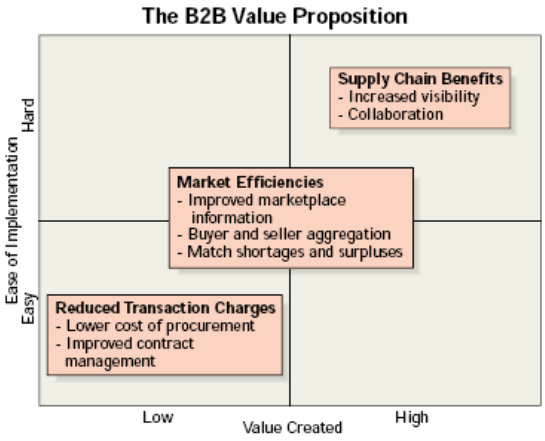
2.1 Business to Consumer (B2C)

Business to Consumer concentrates to retail or sale side of the eCommerce. It is commerce between companies and consumers, involves customers gathering information; purchasing physical goods like books or travel or information goods like downloadable digitized material content, such as software, music or electronic-books. As an example from in B2C field is Amazon.com which based on big variety of assortment is closer to a internet shopping mall.
In B2C area there are working and non-working markets; three has been a great success at least in following areas.
Real estate, consumers can have a several pictures or even 360 view of the apartments, or consumer can search by the price, area or by number of rooms, which ever is convenient for their purposes.
Adult entertainment, which is considered to be very discreet personal and business gains a lot of additional value by enabling non physical contact when doing purchases over the internet.
Travelling; it is easy to enable imaginary view of paradise destination by showing pictures and 360 views of the beaches and accommodation facilities, and consumer being able to purchase the trip just by clicking mouse button. And of course consumer can easily seek for cheapest route or accommodation.
Auctions; being able to bid for a goods over the internet without being present and wait for that one particular object is being auctioned off. drive to the auction place and still there is a big risk that one is not able to get the good with a reasonable price (or not at all). Possible lot of time and effort wasted for nothing.
Banking or personal finance management is a great success, which pertains to the management of personal investments and finances with the use of online banking tools.
Customer support service is a must to have online. Take for example Microsoft. Of consumer is were to call Microsoft every time they need information of support or even better Microsoft were to mail an update CD every time there were a security update or service pack.

Not so successful area for B2C are for example daily groceries which may work for elderly people but distribution in a large quantity could cause problems.
Other area is items that need "touch or trial" like clothes or luxury items.

2.2 Business to Business (B2B)

When eCommerce is extended to supply chain management between and among businesses, we get a new concept, which is called Business to business (B2B). B2B area is nowadays growing much faster than B2C and about 80% of the ecommerce is this type. Companies are able to manage different element along the supply chain like manufacturers, distributors and dealers. So B2B e-commerce is simply e-commerce between two or more companies. Main focus in B2B is on procurement where as B2C already focuses on selling and marketing.
There are two distinct aspects of B2B e-commerce that separate it from the more familiar business-to-consumer (B2C):
Flexibility in pricing; Transactions between businesses often require variability in the pricing of products between purchasers whereas B2C the price is same for everybody or varies rarely in the B2C marketplace.
Integration of business systems; to realize increased productivity and savings, businesses involved in B2B will integrate their internal systems together, enabling less human intervention.
B2B on the internet sounds very attempting, but before making any investment in B2B e-commerce, a company must identify the value created and the effort required for implementation under each of the three categories. Picture 1 depicts that value proposition. The relative position of the three categories will not be the same for all firms, and position will vary based on the supply chain strategy and competitive environment.
A company must tailor its e-commerce implementation to support categories where the value created is high relative to the cost of implementation.



Picture 1: Business to Business value proposition

2.3 C2C e-commerce

Consumer-to-consumer (C2C) e-commerce occurs between private individuals or consumers. Examples of C2C ecommerce are:
● Auctions portals, such as eBay, which allows online real-time bidding on items being sold in the Web;
● Peer-to-peer systems, such as the Kazaa or Napster model where private individual share files containing different kind of data. In Finland it is illegal to share any kind of copyrighted material in peer to networks.
●Different advertising portals like keltainenporssi.fi were individual can sell or buy junk or goods to each other. There are also forums on the Internet, that people can place adds for buying or selling staff related to forum subject.

2.4 Business-to-government e-commerce (B2G)

E-Commerce between companies and the public sector is usually referred as Business-to-government e-commerce. In practise it means the use of the Internet for licensing procedures, public procurement, and other government-related operations. In B2G the public sector has a leading role for establishing e-commerce. Which also is based on a need for public sector make its procurement system more effective. Web-based purchasing policies increase the transparency of the procurement process and reduce the risk of irregularities. Nowadays however, the size of the B2G ecommerce portion of the total e-commerce is only small fraction and insignificant.

2.5 Mobile Commerce (m-commerce)

Mobile commerce or m-commerce is defined as a process of buying and selling of goods or services through wireless technology. Most common representative in this category is of cause mobile phone.
Biggest benefit of m-commerce is, that terminal is portable and there is radio coverage in major cities. There is also increasing amount of services available in m-commerce sector for example;

Data or Information services, which cover for example automatic or manual delivery of sport news, weather information, stock market updates to a mobile device.
Financial services, which covers paying bill or buying stocks, or even getting automatic warnings if money in the account is running low or predefined limit is exceeded.
Service payments**,** as consumers are for example able to pay car wash by call number assigned by the carwash owner. Service is charged with phone bill.

3. Electronic payments

There are several payment methods (and organization) supporting electronic payments and ecommerce over the internet:

- Electronic payment cards (credit, debit, charge)
- Virtual credit cards
- E-wallets (or e-purses)
- Smart cards

- Electronic cash (several variations)
- Wireless payments
- Stored-value card payments
- Loyalty cards
- Person-to-person payment methods
- Payments made electronically at kiosks

When looking at list above it is obvious, that there are several issues to be taken into account when creating a electronic payments system like:
Authentication which identifies buyer and also makes sure that person is who he/she claims to be. Used methods are for example digital signature, finger prints, password or smartcards etc.
Data integrity which means, that there must be a way to verify that data is not changed during the transactions.
Confidentially must be preserved, so information concerning the tarns action are need to know basis.
Non repudiation, which means that person who did the payments is not able afterwards deny doing so.

4. e-Commerce software security

For average Joe internet feels like great black hole when giving for example credit card information into it. So sense of security needs to be established without any doubts. Customers must be able to select a mode of payment and the software related to that, on the other hand must verify their ability to pay. This can involve credit cards, electronic cash or purchase orders. Specialized software such as cyber cash or eWallet can verify the purchaser and the purchase

4.1 Security protocols

There are several protocols defined for secure ecommerce transaction, and most famous are SSL and SET.

4.1.1 Security Socket Layer protocol SSL

SSL is the protocol that encodes the whole session among computers and provides the safe communication service on Internet. It is widely used eCommerce transactions. SSL Protocol was developed by Netscape Communications Corporation. The protocol is composed of two layers. At the lowest level, developed on top of some reliable transport protocols like TCP, there is the SSL Record Protocol which receives non interpreted data from higher layers in non-empty blocks of arbitrary size. The SSL Record Protocol is used for the encapsulation of various higher level protocols, like the SSL Handshake Protocol. Handshake protocol allows the client and server to authenticate each other and to negotiate an encryption algorithm with its associated cryptographic keys before the application protocol transmits or receives its first byte of data. Great advantage of SSL is that it is independent of an application protocol. A higher level protocol can be built on top of the SSL Protocol transparently. For online communications, SSL allows traffic between a Web server and a clients like Web browser to be strongly encrypted, using the public key technology.
When compared with SET Protocol for online electronic transactions, the major disadvantage of SSL is that it cannot prevent personal information from being stolen. Furthermore, the merchant can examine or tamper this information. Below Comparisons between SET and SSL can be found in .

4.1.2 Secure Electronic Transaction (SET)

Secure Electronic Transaction (SET) was incorporated by Visa and MasterCard with participation from several technology companies including IBM and Microsoft. This system means that your entire credit card number is never travelling across the net- rather pieces of it are- and that no human eye sees the entire card number. SET supports electronic commerce security based on Certificate Authority (CA).
SET protocol includes a payment section which is able to deal with different credit cards, and it applies an acquirer payment gateway which is able to authorize the usage of existing bankcard networks. In the authorization request sent by the merchant to the acquirer, the purchase instruction of the customer enables the acquirer to verify that the merchant and the buyer agree as to what is purchased and how much is authorized.
SET is a common secure electronic commerce payment protocol where five parties, namely, (1) customer, (2) seller, (3) payment gateway, (4) certificate authority and (5) issuer, are involved in the payment process. Although SET is secure for making online electronic transactions, it is not recommended for micro-payment because it is consider to be time consuming, because of the several parties involved. Besides, all parties may have to authenticate themselves, for security reasons, introducing more penalties performance wise.
SET made possible the work of information integration, verification of all financing data and coding of sensitive data. It realized the financing payment safety work of attesting cardholders, supplier, payment request, payment authorization and records of payment by use of advanced technology like data coding and digital signature.

	SSL	SET
Protocol Type	Secure communication protocol (end to end)	Secure payment protocol (multi party)
Entities	Buyer to seller	C, M, PG
Authentication	Only merchant authentication	Mutual authentication
Privacy	No privacy from merchant	Good: by using dual signature
Ease of Use	good: convenience	Consumer credit card certification required
Mobility	Good: can be used on any machine	Fair: restricted on computer installed SET certification
Efficiency	Good:	Fair: due to the complex cryptography
Popularity	Very adopted	Not very adopted

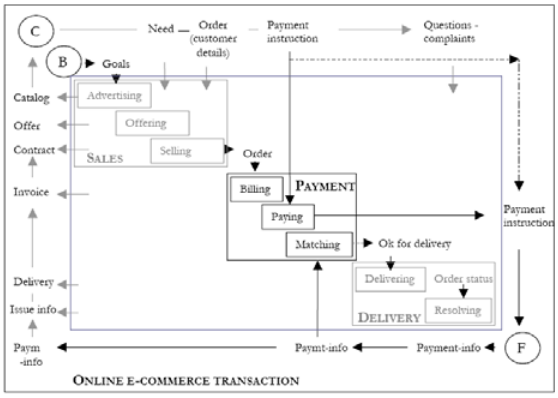
Table 1: Comparison of SLL and SET protocols

More traditional and safe way (if one does not trust internet security) is that Consumer can just order and payment is by cash upon the delivery (i.e. postal office) of the physical goods or paying directly to given bank account.

More modern solutions are for example eCash which is short for electronic cash, computer based system which allows item to be purchased credit card or money order providing secure on transaction and processing. A popular ecash provider is for example PayPal.

Consumer can also have a digital wallet (e-wallet) which can hold digital money that is purchased similar to traveller's checks or to a prepaid account. The wallet may reside in the user's machine or on the servers of a Web payment service. When stored in the client machine, the wallet may use a digital certificate that identifies the authorized card holder. Microsoft's Passport and Yahoo! Wallet are examples of digital wallets.

4.1.3 Typical transaction process



Picture 2: Typical transaction process

There is not only a way to do the ecommerce transaction, but typical there eCommerce has following elements:

- Advertising: the company communicates its products and services for example makes a catalogue
- Offering; the company offers specific goods and services,
- Selling; the company agrees with the customer on the content of a specific order
- Billing; the company produces the invoice,
- Paying; the buyer pays the seller by giving a payment instruction,
- Matching, where the seller matches the payment information like the authorisation results and the actual crediting of account.
- Delivery, where the seller delivers merchandise to the buyer.
- Resolving; the seller and buyer try to resolve delivery or payment issues related to the purchase.

This could be considered as on of the basic transaction flow chart, but it is up to seller to decide how he wants use e-commerce process (and of course buyer to accept it).

5. Case Airline business

Airlines can be considered as pioneers when it comes to ecommerce and reason are easy to understand, if we are thinking about the nature of the business.

Airlines companies at least the larger ones are operating all over the globe, and if not just by them selves there are several co-operation alliances available, who co-share to routes route network. Meaningless to say, what is the best way to share information about the routes, prices or availabilities, is via networks of course.

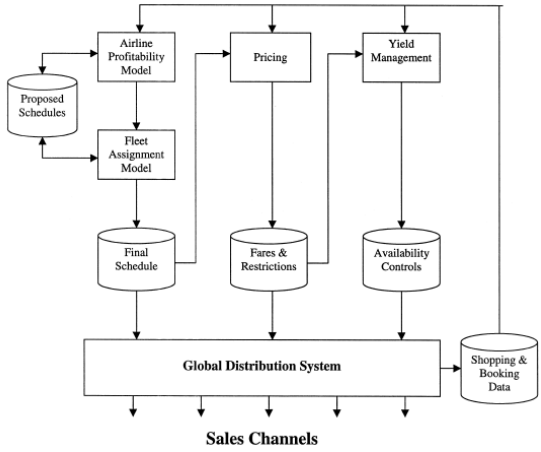
Airlines have to reach the customers from all over the world and the nature of the product sold is very convenient for eCommerce; Customer pays the ticket on the internet, gets the eticket via email or even by sms – message, and just shows up to the airport before the flight.

If more personal services are needed, airlines can have a local dealer or agent, and information for agent is provided via different eBusiness solutions.

Since customer price awareness increases when all of the companies are available and comparable on the internet, it creates pressure for the airlines to search for savings. Ecommerce is very a economical way of selling increases the popularity among the airlines. There are low cost carriers which are basing their selling totally on ecommerce.

The USA air travel market has expanded rapidly over the last few years, due to this familiarity the pricing and because of the perception that relatively low-cost travel is available via the internet. It is predicted that E-Commerce sales will account for the majority of air travel sales by 2010.

Ecommerce offers other than low cost distribution advantages for the airlines. For example the e-commerce infrastructure the airlines developed allows collection and central storage of sales and marketing data. Airlines use this data to drive decision support tools for planning and marketing. Data collected and stored using the e-commerce infrastructure drive airline scheduling and yield management. Airlines use the sales and marketing data to build "optimal" schedules. They also use the data to set "optimal" prices and yield-management controls.



Picture3: e-Commerce infrastructure of typical airline.

6. Conclusion

What does the future hold for e-commerce? I would say that once the trust in won and frauds are beaten, there will be an increasing market for eCommerce. Shop are more and more congested, fuel cost more and more and internet connection and PC are getting cheaper and cheaper. When we put all this together one can not avoid coming to a conclusion that there are huge possibilities for eCommerce and it will probably increase exponentially. On the downside, some experts predict that it will be increasingly difficult for smaller companies to establish their presence. Customers are in most cases using brand information and internet search engine to find what they are looking, and there must be a hit before there is ecommerce. One the other hand if you compare for example for weekly newspaper add it is cheap advertising. And for those considering opening a virtual storefront, forthcoming technology and standards agreements will make it easier to create a site, to protect it against payment fraud, and to share information with suppliers and business partners.

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MOBILE TV

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Abstract

The aim of this report is to present the concept of Mobile-TV and to discuss it from the telecommunications business point of view. Special focus is given on the DVB-H standard.
In the first part, the report presents the different technologies and standards related to Mobile-TV. The second part describes the different services that the DVB-H standard can offer and the possible business models it enables to different players. In the third part the report discusses some important factors that vendors need to consider in their strategies and presents the current strategic positioning of the major vendors.

Key Words
DVB-H, T-DMB, Finnish Mobile-TV pilot, Time-slicing

1 Introduction

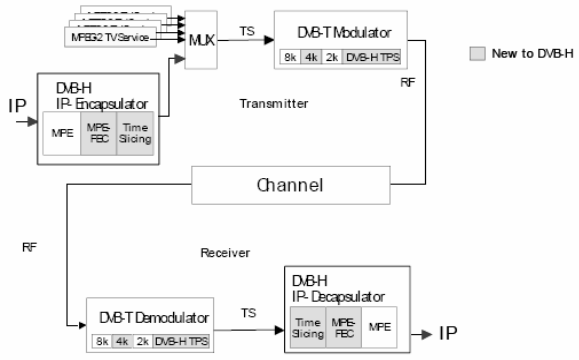
Mobile operators and content providers have been struggling to find a service that would satisfy customer needs and be profitable. There have been some applications that are considerably popular and beneficial, like different music services, but have not really taken off. Lately the industry has turned its eyes on Mobile-TV and it is considered to be the next big thing in applications. Operators are heavily relying on that it would increase the data consumption and would fill the overcapacity. Handset vendors are also keen to sell new, high end phones that will play Mobile-TV.
Mobile-TV is still mainly on introduction phase. There have only been some real implementations and many pilot projects. This is mainly due to the fact that there are couple competing technologies and the winner is yet to be solved. DVB-H technology is the leader at the moment. It has lots of big players backing it and running pilot projects around the world. Markets are waiting to see what happens and when the winner is chosen. In case that there will be many winning technologies, growth will probably be much slower.
Handset vendors are taking different strategies with Mobile-TV devices. Many are waiting to see which technology wins and are launching only one or two models at the moment. Samsung, on the other hand, is launching various models for all technologies so that it would be on a good position which ever technology happens to win. Vendors are also forming allies to back some technology and to gain as much other players to back it also. Mostly vendors seem to be reluctant to provide handsets for many technologies and are putting pressure to markets to choose one technology.
Mobile-TV enables also various new services. Content providers seem to be delighted for this new boost for developing new kind of applications. It enables a whole new category of services. If it fulfills the expectations, it will be very profitable to all providers.
Mobile-TV has still many obstacles to overcome, but at the moment it looks very likely to be the next killer application in mobile business.

2 Technologies and Standards

This chapter describes different and rival mobile-TV technologies in use. First technology discussed is DVB-H which is the technology most focused on this report.

2.1 DVB-H

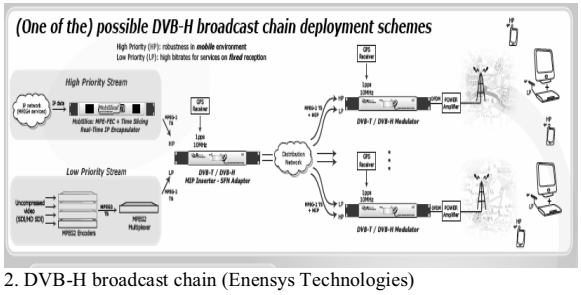
DVB-H (Digital Video Broadcasting Handheld) is the latest development from the DVB family, targeted for handheld devices like mobile phones and PDAs. It became an ETSI standard in November 2004. DVB-H technology enables the simultaneous transmission of multiple television, radio and video channels to mobile devices. It combines traditional broadcasting standards with mobile devices specific features. To receive DVB-H transmissions, handheld devices require an additional integrated receiver (Finnish Mobile TV).



1. A conceptual description of a DVB-H system (Transmission System for Handheld Terminals (DVB-H), ETSI EN 302 304 V1.1.1 (2004-11) Standard)

The objective of DVB-H is to provide efficient means for carrying multimedia data over digital terrestrial broadcasting networks to handheld terminals (Digital Video Broadcasting (DVB); Transmission System for

Handheld Terminals (DVB-H) 11.2004). DVB-H builds on the capabilities of DVB-T, but overcomes the two key limitations of DVB-T technology. It extends the battery life of device and improves the robustness of the difficult reception environments with built-in antennas (DigiTAG - The Digital Terrestrial Television Action Group 2005). Main technique DVB-H uses to reduce battery consumption is time-slicing. Time-slicing consists of sending data in bursts using significantly higher bit rate than if the data was transmitted using traditional mechanisms. Between the bursts, data of the elementary stream is not transmitted, allowing other elementary streams to use the bandwidth otherwise allocated. Time-slicing enables a receiver to stay active only a fraction of the time, while receiving bursts of a requested service. Time-slicing also supports the possibility to use the receiver to monitor neighboring cells between bursts. By switching of the reception from one transport stream to another, during an off period, it is possible to accomplish a quasi-optimum handover decision as well as seamless service handover. For better transmissions is used technique called MPE-FEC, which adds an optional multiplexer level. The objective of the MPE-FEC is to improve the C/N- and Doppler performance in mobile channels and to improve the tolerance for impulse interference. By adding parity information calculated from the datagrams and sending this parity data in separate MPE-FEC sections, error-free datagrams can be output after MPE-FEC decoding despite a very bad reception condition (Transmission System for Handheld Terminals (DVB-H), ETSI EN 302 304 V1.1.1 (2004-11) Standard).
There are lots of different pilot projects going on around the world for example Finnish Mobile-TV Project, Crown Castle's Project in Pittsburgh, Australian Mobile-TV Project and commercial pilot in Oxford, England (DigiTAG - The Digital Terrestrial Television Action Group 2005). Most ambitious device developer at the moment is Nokia, which attends nearly every possible Pilot Project. All the other major players, including Motorola and Samsung, have DVB-H receivers in their catalogs.



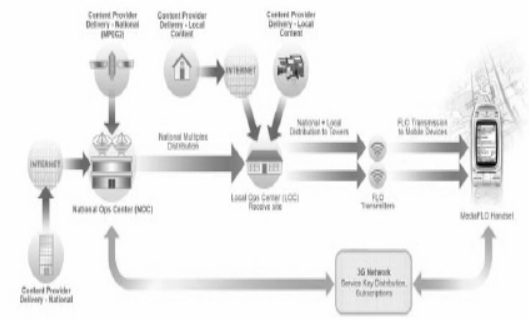
2. DVB-H broadcast chain (Enensys Technologies)

2.2 DVB-T

DVB-T was first published in 1997 and it wasn't targeted for mobile receivers. However, following positive results, DVB-T mobile services had been launched in Singapore and Germany. Despite the success of mobile DVB-T reception its major downfall is battery life. The current and projected power consumption is too high to support mobile devices that are supposed to last a long period with a single charge (DVB-H white paper 2004). Another issue for DBV, which is improved in DVB-H, is IP-Datacasting. These will facilitate the interoperability of telecommunications and broadcasting networks, a complex topic involving detailed work on interface at different service levels (DVB-T white paper 9.2004).
DVB-T is the world's most used digital terrestrial television system, but the situation is most obviously going to be changed by DVB-H or MediaFLO. DVB is already focusing its effort more and more to DVB-H technology.

2.3 MediaFLO

MediaFLO is a technology developed by Qualcomm Company. It is based on FLO (Forward Link Only) technology, which is orthogonal frequency division multiplexing (OFDM)-based air interface designed specifically for multicasting a significant volume of multimedia content to wireless handsets (MediaFLO white paper 2005).
MediaFLO system consists of two components: FLO-technology and Media Distribution System (MDS). FLO technology is designed for markets where regulations permit high-power transmission from a single tower or a small number of towers. FLO can be also be deployed across wide area regions using a network of transmitters, spaced 60 km apart (MediaFLO white paper 2005).
The MDS is a client-server solution that cooperates with FLO to provide the service layer necessary for an optimal content delivery. The MDS provides the tools to assimilate and aggregate content, bundle channels into subscription packages, and ultimately merchandise and deliver this content securely to wireless operator target subscribers. Wireless operators can also leverage additional MDS features to entice users to engage with other media (video on demand, music on demand, ring tones, games, etc.) over their third generation (3G) networks while viewing content delivered over FLO. (MediaFLO System Brochure).
MediaFLO is a big and hyped technology in North-America. Yet it hasn't really landed to Europe or Asia, but Qualcomm's position as a big company and influencer can change the situation. One MediaFLO's downside at the moment is that they don't have many device vendors backing the technology.



3. MediaFLO technology (MediaFLO white paper 2005)

2.4 T-DMB

DMB (Digital Multimedia Broadcasting) can operate via satellite (S-DMB) or terrestrial (T-DMB). DMB is based on Eureka 147 standard, also known as DAB, and has some similarities with DVB-H. It is operated in band 3 from 174 MHz and in L band from 1452 to 1492 MHz and is narrowband solution. T-DMB Services started in South Korea 1.12.2005 and there are some pilots starting in Europe in 2006, for example in Germany, France and UK (Wikipedia DMB).
DAB technology has vast amount of users and about 800 services worldwide. Most of them are directed to mobile radio users and won't affect mobile-TV users (World DAB organization).

3 Services and Business Models

3.1 End User Services

IP-Datacasting in DVB-H network enables various types of services for the end user. These services can be categorized at least to Streaming, Interactive, Non-interactive and Application/Software services. There is also a possibility for an electronic service guide (ESG) that provides a selection of available services to the user.

3.1.1 Electronic Service Guide

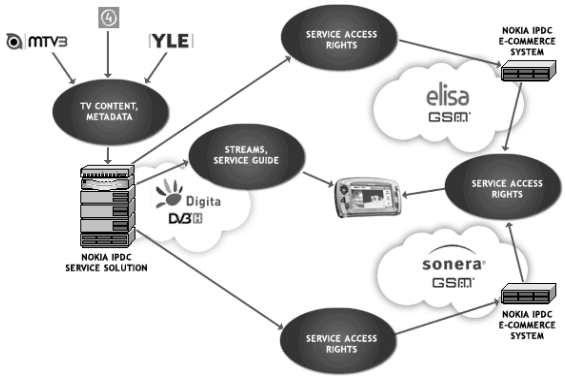
Electronic Service Guide (ESG) is very similar to the EPG service provided by many digital-TVs. It can show the available services, status of some download and could offer an interface for other programs. Many different kinds of features can be implemented in the ESG. For example, an alarming system for user to know when some program starts is a possible feature.
It is possible that network operator, service operator, terminal manufacturers and content aggregators could all have their own ESG.

3.1.2 Streaming Services

Streaming services includes video and audio. This includes services such as traditional TV-programs (live or reruns) and radio channels. Streaming content data is not usually saved on the end device but is viewed at the same time as it is broadcasted. Those can be viewed at any time during the broadcast, as it is with traditional TV and radio broadcast (Finnish Mobile TV).
TV programs that are broadcasted to mobile handsets will probably consist of traditional TV shows and of tailor-made fast-paced content aimed at mobile reception. Mobile tailored TV-programs could include for example drama or action series that last only some minutes.

3.2 Interactive Services

Interactive services include a one-way or a two-way return channel for possible interactions with the content. The return channel can be data channel provided by the mobile operator such as a GPRS connection. Services such as online shopping or interactions with TV-program are possible implementation solutions. For example, TeliaSonera Finland designed and implemented a service for online movie ticket buying, where the user could view the trailer and get the information about the movie prior buying the ticket.



4. Finnish Mobile-TV plattform (Finnish Mobile TV)

3.2.1 Non-interactive services

These types of services don't need a return channel. Data is retrieved prior the usage to the end user device. Services like TV-guide information and news services are ideal for this. Application/Software services

3.2.2 Software Services

Through IPDC it also possible to send application for the end user such as games, music and software update. This type of service is however better for end users that have a fixed reception due to the need of high capacity of hard drive.

3.3 Mobile-TV pilots

There are several DVB-H pilots running currently in various countries. At the moment of writing this report, only few of the pilots have come out with results. The pilots programs held in Finland and Paris France are presented.

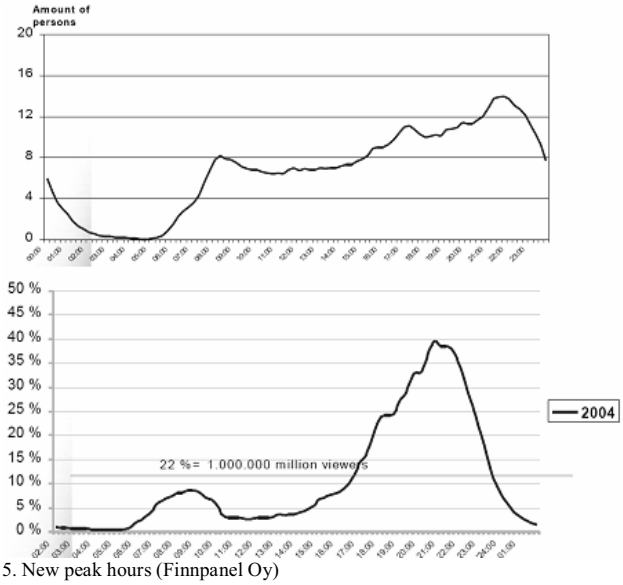
3.3.1 Finnish pilot program

In early 2005 a pilot program was started in Helsinki by parties involved from network operators, mobile operators, broadcasters and hand device vendors. In the pilot program, hand device vendor Nokia, provided Nokia 7710 media devices to 500 test users of different

ages. Commercial aspect was applied by service payments and a user survey was conducted during the pilot program.

The pilot program reached its target and was considered successful. (Finnish Mobile TV)
Some of the major results were as follows:

- 41% of pilot participants would be willing to purchase mobile TV services and half thought that a fixed monthly fee of 10 euros was a reasonable price to pay.
- Over half (58%) said that they believed broadcast mobile TV services would be popular.
- According to the pilot results, pilot participants not only wanted to watch familiar program offerings, but they would also welcome mobile TV content that is suitable for short and occasional viewing
- Participants also watched mobile TV at different times than traditional TV peak hours.
- In general, mobile TV users spent approximately 20 minutes a day watching mobile TV
- Mobile TV was most popular while traveling on public transport to relax or to keep up to date with the latest news although it also proved popular at home for entertainment and complementing participants' main TV watching.



5. New peak hours (Finnpanel Oy)

3.3.2 France pilot program

The pilot program in Paris France was started in September 2005 with a nine month authorization to broadcast. CANAL+ was the main organizer and there was 500 participants. 250 of them were selected from CANAL+ subscribers and 250 from SFR telecom network operator
The handset was Nokia 7710 and the network infrastructure was provided by Towercast Company.

Some selected early results of the pilots program were as follows

- average viewing time of 20 minutes per day
- 50% of the participants stated that they watched mobile TV mainly at home, 14% while travelling (to be weighted by the absence of coverage in the metro during the pilot) and 12% in the workplace
- 3 periods of highest use: morning (9/10H), midday (13/14H) and evening (20/22H). 18% of participants stated that they watched TV once a week, 57% several times a week and 25% once a day
- The most watched programmes were: news, music, entertainment, sport, documentaries and, for the CANAL+ testers, films
- 73% of participants said they were fairly or very satisfied with use of the service. 68% would be prepared to take out a subscription as proposed in the pilot for 7€/month or more
- More than 80% said they were satisfied with the content proposed
- For some participants, it was also possible to establish a link between time and place: short viewing periods (less than 5 minutes) in a waiting room, while waiting for the metro (the Place d'Italie station has DVB-H coverage), at a friend's house / intermediate viewing periods (up to 30 minutes) in the car, bus / longer viewing periods (more than 30 minutes), indoors (home, restaurant, etc.)

(Paris Mobile TV Customer Trial)

3.3.3 Pilot program conclusions

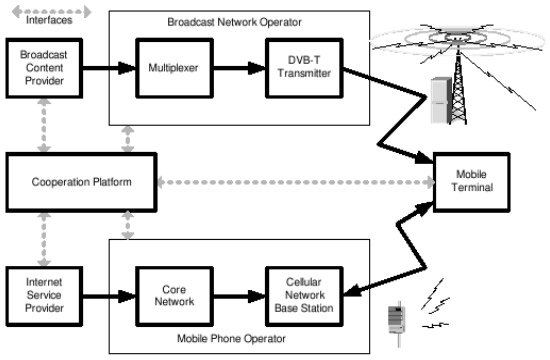
Both of the pilot programs results would indicate a positive future for the DVB-H Mobile-TV. From both of the pilot programs large part of the participants were willing to pay for the service a monthly fee. 43% in Finland were willing to pay 10 euros and 68% in Paris were willing to pay 7 euros or more.
It is surprising to see that 50% of the participants in the French pilot program stated that they watched Mobile-TV mainly at home, were as in Finland, most popular place to watch Mobile-TV was on a public transportation. This would indicate that customer preferences differ on usage models for Mobile-TV depending on country. The high usage of Mobile-TV at home indicates also the need to ensure high quality coverage inside buildings. However, participants in Paris were also active to use Mobile-TV while on the move as in Finnish pilot. In both programs participants watched average 20 minutes per day. This would highlight the fact that mobility of TV creates new peak hours and need for mobile specific shorter programs.
The new peak hours for the Finnish mobile-TV pilot can be seen in the picture 5. The upper picture shows the mobile-TV usage and the lower traditional TV usage.

3.4 Influence to the Mobile-TV players business models

Mobile-TV is still quite new service model and has little real market data of its usage, although Korea has some ongoing T-DMB projects.
If Mobile-TV will become a success and fulfill its expectations, it will have great impact not just on the traditional mobile business value chain but also on the traditional broadcast businesses. A new mobile broadcast business will evolve from both of the businesses. A mobile operator can become a TV program broadcaster and traditional TV programs content provider and broadcaster can become a mobile operator.

3.4.1 Mobile Operators

A tradition mobile operator can play a meaning role in the Mobile-TV value chain. Mobile operators have chance of create revenues by increasing their data traffic through the return channels on interactive services, offer e-commerce and billing services to partners, make additional use of mass infrastructure for DVB-H boosters and create a new unique program channels that provide opportunities for brand differentiation.



6. System architecture for collaboration between mobile and broadcast operators (DigiTAG - The Digital Terrestrial Television Action Group 2005)

3.4.2 Network operators

Network operators that already have DVB-T installed, gain advantage because DVB-H utilizes existing mast and transmit networks, making the most of the its capacity. This way the network operator could increase revenues with fairly low investment.
Traditional mobile network operators however could start migrating to broadcasting industry through investing into DVB-H network. Existing knowledge and capability in networks would be beneficial and might create competitive advantage.
In Finland, network operator Digita owning the Finnish network for DVB-T and mobile network operators Elisa and TeliaSonera applied a licence for building DVB-H network (Digitoday). It happened that Digita received the licence.

3.4.3 Broadcasters, Content Aggregators and Content Providers

Mobile-TV creates new peak hours and enlarged audience for broadcasters as the Finnish Mobile-TV pilots program indicated. This way, especially broadcasters could benefit from economies of scope.
People can now watch TV in busses, parks and other non traditional TV viewing places. They are no longer constrained to fixed television sets. This provides new ways to enlarge broadcasters' business model. Mobile TV provides an opportunity to generate new growth from investments in switching to digital from analogue. It can open door to new business opportunities with mobile network operators.
Broadcasters can produce or buy new mobile specific content, use the new peak hours to rerun or advertise and offer unique content for short viewing periods. It enables them to create a totally new audience that can be program and brand specific.

3.4.4 Handset Vendors

Handset vendors cannot neglect mobile-TV feature if mobile-TV becomes successful. It will probably play a major role in creating competitive advantage in the beginning. Big players such as Nokia will have lead due to the high research and development investment needed.
Mobile-TV will be yet another feature to prevent handset drifting to decline path in their life-cycle.

4 Vendor Strategies

Whether handset vendors should pursue cost- or differentiation based strategy or some other specific strategic actions are beyond the scope of this report. We will present some important strategic factors that vendors need to consider and the current strategic positioning of major handset vendors.

In the early stages of Mobile-TV's lifecycle, vendors and other players need collaborative efforts and strategies to launch the service and reach the critical mass. This means that handset vendors need to co-operate with other value chain members and make investments that will even have spillover effects. Especially vertical co-operation is needed.
Currently there are many strategic alliances and test programs being formed. For example Nokia, Intel, Motorola and TI has recently formed a strategic alliance to push mobile-TV to the masses in North America and in Europe Samsung made a deal with three French mobile operators to create the first T-DMB trial service in France (Electronic News)

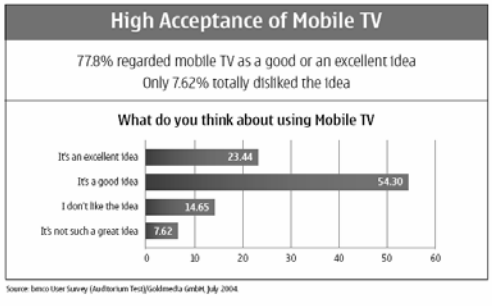
The handset product design strategy will need constant focus. Tradeoffs between size, power consumption, integration and price are needed. Question that handset vendors face, is how to balance the need for stylish and

compact phones against the need for large screen. However, there are positive signals in the market for the usage of small screen size videos like Sony PSP and video Ipod.

Handset vendors should also take part in bundling broadcasters, mobile operators and handset vendor's products and services. Bundling would increase collaboration, build customer trust and enable more coherent services.

4.1.1 Nokia

As mentioned earlier, Nokia is taking apart to almost every possible project concerning Mobile-TV and DVB-H. Nokia clearly wants to have effect on how technology and markets evolve. Main reason might be that their own surveys suggest that around 20% of active mobile phone users are highly interested in getting the service and prepared to pay a realistic charge for it (Nokia, Mobile-TV brochure). Nokia also is the first company that has put out clear specs for their first Mobile-TV phone device, N92.

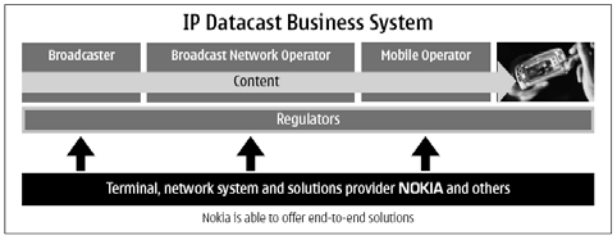


7. Mobile-TV acceptance (Nokia)

Nokia is putting all its efforts to the DVB-H at the moment and not looking any other options. This indicates that they believe that DVB-H is going to be the leading technology that takes over the markets. Nokia is justifying its decision by saying that:

- DVB-h is the best delivery system currently available,
- Its an approved ETSI standard,
- It benefits from existing DVB-T infrastructure components, which reduces initial investments in many cases,
- It offers an excellent, broadcast-quality picture, because the screen resolution is of a similar standard to VHS,
- Battery consumption is reduced by 90% due to time-slicing technology and
- It will be accessible by an estimated audience of approximately 300 million mobile users by 2006 (Nokia, Mobile-TV brochure).

Nokia also wants to have its share of network markets. It has developed its networks simultaneously and clearly wants to include both issues in its business model.



8. IP Datacast business system (Nokia)

Nokia's biggest concern at the moment seems to be possible lack of content providers and operators interest. Nokia is afraid that not enough interesting content is provided and customers reject the idea of Mobile-TV. That is why they have launch campaigns to gather interested parties around it support them (Nokia, Mobile-TV brochure).

4.1.2 Samsung

Samsung stands out as the sole big Asian manufacturer at the moment. Situation will most likely to be changed right after markets have chosen the winner standard. Samsungs strategy differs drastically from Nokia's or Siemens's. It has just announced to have launched nine different device models for different standards (Samsung press release). It has decided to support Satellite DMB (S-DMB), Terrestrial DMB (T-DMB), DVB-H and MediaFLO. This clearly indicates that Samsung doesn't dare to bet which technology will win and it invests to all technologies. When the markets have chosen the winner technology, it will be ready, but will not probably have leader position. It may also think that different geographical markets end up with different technologies and wants to be major player in all continents.

4.1.3 Motorola

Motorola is clearly the biggest player in American markets. It also hasn't taken so much part to pilot projects and has most obviously been waiting to see where markets evolve. So it was a little surprise when they announced to have founded a joint alliance called Mobile DTV Alliance with Nokia, Intel and Texas Instruments (Mobiledia.com). Purpose of the alliance is to promote the evolution of DVB-H. Also the software giant Microsoft has announced participation in Mobile DTV Alliance to help accelerate DVB-H deployment in North America (Mobile DTV Alliance).

5 Conclusion

Handset vendors and mobile operators are eager to find a new killer application that would slow down the diminishing returns in telecommunication business. Mobile-TV is expected to refresh the business and enable a new wave of possible revenue channels. At least the positive results of Mobile-TV pilot programs support the expectation. However, the players in the telecommunication business have had great

expectations before that have ended up being big disappointments.

Mobile-TV's strongest advantage is the service concept of traditional TV which is world's most popular entertainment product. It has already positive results from already launched services in South Korea and Pilot Programs.
Mobile-TV also gives new boost for handset vendors, especially in the high end segment. Vendors can also revise their pricelists by adding Mobile-TV feature.
It can also help the Operators to fill their capacity and encourage content providers to come up with new features.

Despite all the possible advantages Mobile-TV has, there is a threat that mobile-TV will never become real revenue earner. People already spend a lot of money on different TV channels and mobile services. This could lead to a situation where there is no will to pay for services that are largely already paid for. Disadvantages such as small screen size, possible copyright fees, bad coverage and many other issues need to be solved to minimize the risks. Mobile-TV can become just one of the "must" services that operators have to offer to stay competitive and keep their customers faithful.

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TRIPLE PLAY SERVICES

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Abstract
The purpose of this paper is to explain how ADSL technology is making possible the development of businesses around Triple Play services. How bundling of services to ADSL connections are comparable to independent services like Skype.

This paper introduces how Triple Play affects on operator revenues and how it can increase customer loyalty.

Key Words
ADSL, Triple Play, broadband, video on demand, VoIP, bundling.

Introduction

Triple Play service is a marketing term. It means three services, high speed Internet, television (which can be broadcast or video on demand) and telephone service. All three at the same time have to have broadband connection for a good Quality of Service (QoS).

Triple Play services are delivered using a combination of optical fiber and digital subscriber line (DSL) technologies.

ADSL technology makes broadband connections available, before switching to fiber cables. It is used to deliver high rate digital data over existing copper phone lines.

Triple Play services can be offered by digital television operators as well as by telecommunication operators. It makes possible for both service providers to compete with one another. That kind of integrated solution could increase switching costs for customers who may want to choose between service providers.

1. ADSL Technology Development

Asymmetrical Digital Subscriber Line (ADSL) technology belongs to a group of technologies, known as xDSL, where x denotes a particular type of DSL. These technologies were in development for a few years, but they became commercially viable only in the last decade. They became more widespread in the 21st Century. ADSL is one of the most popular technologies of the xDSL family. It dominates the residential market and a part of the commercial market. From 2004 more than 65 million ADSL lines were in use around the globe.

2. ADSL Historical background

ADSL began with demonstration of Joseph Lechleider, of Bellcore. He developed the idea of asymmetry, the A in ADSL. It suggested that a higher rate of data could be sent in one direction. This was the beginning of the move from analog to digital.

The first efforts of this new technology created ISDN (Integrated Services Digital Network). It is a system of digital phone connections. It allows voice and data to be transmitted simultaneously across the world. The result of this is that more data could be transmitted at the same time, thus creating more speed.

The first widely used DSL was HDSL (High bit-rate DSL). It gave an equal amount of wideband digital transmission in both directions. It was developed in the early 1990s and was one of the oldest forms of DSL. HDSL service provided equal bandwidth for both downloads and uploads, but required multiple phone lines to do this. Now the technology was available to achieve the dream of delivering video-on-demand. However, the idea didn't catch on and the industry never really fulfilled its desires.

DSL emerged much differently than was originally expected. PC users needed high-speed access to the Internet. Considering the fast pace of business and the amount of networked computer systems, high-speed DSL became the solution.

3. DSL Technology Expansion

DSL had achieved to bring high-speed information to homes and businesses over ordinary copper telephone lines. With the technology advance, xDSL became the common term for the whole DSL family. It had variations like ADSL, RADSL and VDSL.

ADSL provides greater bandwidth for downstream, from provider to consumer, traffic at the expense of upstream, from consumer to provider, bandwidth. Usually home users frequently download large amounts of Web site data but upload relatively small amounts of data. ADSL takes advantage of this typical way of Internet use.

Technological advances are carrying DSL with them at a fast pace. But eventually some problems like unavailability in certain areas, and poor Quality of Service (slow and interrupted services) challenged the

industry. New DSL versions came to change the problems.

RADSL (Rate-adaptive DSL) is an ADSL technology utilizing helping software. This software determines delivery rate at which signals can be transmitted and adjust the data rate accordingly.

VDSL (Very-high-data-rate DSL) promises much higher data rates over relatively short distances. It was developed to support exceptionally high-bandwidth applications such as High-Definition Television (HDTV). VDSL relies on fiber optic cabling.

First, broadband DSL demand caught fire in the Far East, which, according to industry analyst firm Point Topic, had nearly 8 million DSL subscribers at the end of 2001. This was just a part of the explosion of the global DSL subscriber base to 18.7 million users at the end of 2001.

4. Finnish and International ADSL Market Comparison

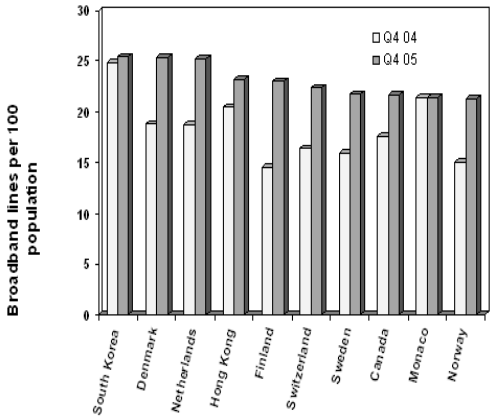
Table 1. DSL lines (in 000's) in major countries: Europe, Middle East and Africa (Mueller 2006)

	DSL lines		
Country	Q404	Q405	Q404-Q405, % Growth
Germany	6700	10400	*55.22*
France	6293	9391	*49.23*
UK	4147	7184	*73.22*
Italy	4464	6387	*43.08*
Spain	2583	3876	*50.07*
Netherlands	1843	2460	*33.46*
Belgium	1032	1277	*23.73*
Sweden	880	1255	*42.61*
Switzerland	785	1098	*39.87*
Poland	668	1254	*87.72*
Russia	194	437	*125.26*
Turkey	457	1542	*237.74*
Denmark	646	813	*26.01*
Israel	650	800	*23.08*
Finland	550	915	*66.20*
Portugal	428	677	*58.11*
Austria	442	650	*46.93*
Norway	562	803	*42.92*
Other EMEA	1243	2544	*104.67*
EMEA Total	**34567**	**53763**	***55.53***

During the fourth quarter of 2005 the worldwide total of broadband lines grew to 209.3m lines, which increased by 37% from 153.3m lines on 31 December 2004. The total number of broadband lines thus added between the end of 2004 and the end of 2005 was 56.2m. Whereas the third quarter of 2005 showed an increase in the actual number of lines which was definitely higher than in previous quarters, the growth rate in the fourth quarter dropped, returning to the expected average of 8%. While 12.4m lines were added in Q1 2005, 13.1m in Q2 2005, 15.1m in Q3 2005, Q4 2005 showed only a small further gain with 15.5m being added. Quarterly growth in percentage terms remained steady, ranging from 7.9% to 8.4% during 2005. (Table 1) (Mueller Katja (ed.) 2006)

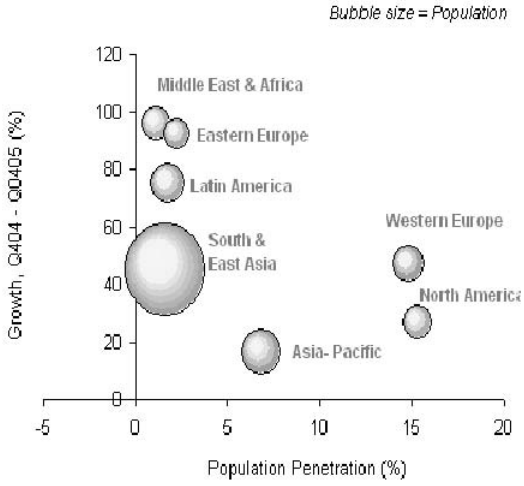
We can see that the global trend is stable without any noticeable sign of either slowing down or accelerating, despite exceptionally low penetration rates in many regions and the potential for broadband lines.

Figure 1: 'Top Ten' broadband countries by population penetration: 31 Dec 2004 - 31 Dec 2005 (Mueller 2006)



South Korea showed negligible broadband growth in 2005 but still has over 25% penetration of broadband. (Figure 1) Denmark and The Netherlands are only a fraction of a percent behind it. As the graphic shows, Hong Kong and Finland are also close, both having reached a 23% penetration level.

Figure 2 Broadband penetration and growth by world region (7): 31 Dec 2005 (Mueller 2006)



EMEA (Europe, Middle East and Africa) Region is leading increasingly the worldwide roll-out of

broadband. The Middle East, Africa and Eastern Europe, are the fastest growing of the seven regions considered as Figure 2 show. Their overall penetration levels are still low. (Figure 2)

Western Europe on the other hand has almost caught up with North America as the most high-penetration region, but is still growing considerably faster. Western Europe's 47% in 2005 as against North Americas 27%. Unless broadband growth in Western Europe goes through a very sharp slowdown, it will soon be ahead of North America.

Finland's broadband penetration is fourth in Europe, which was 33% of the households in January 2005. At the end of December 2003 there were 470,000 total broadband subscribers in Finland. In one year, number of subscribers increased by 60%. Coming to the end of December 2004 the number increased to 750,000. The regional availability of broadband reached 94.1% of the total households.

5. Biggest Players in Finland

Finland's telecom service inherited its unique structure from history before privatization. The telephone service across the country was mostly in the hands of local, municipal operators. For example Helsinki Telephone Company, now renamed Elisa. Many companies had less than 100,000 lines. Sonera, ex Finnish PTT (the incumbent operator), entered the market to support a municipal phone company. It helped providing local service, long-distance and international service in thinly-populated areas.
Same structure has remained mostly same after privatization and in the era of competition. Finland's initiation of new fixed-line technologies, such as DSL has also been fragmented. There are very different experiences in different parts of the country.

Sonera
Sonera is the major telecommunications operator offering DSL services in Finland. At first, in 1998 the operator offered DSL services to business customers. The offering of high-speed Internet services to business customers began in June 1999. In May 2000 Sonera launched its first DSL services for residential customers, Home ADSL.
Its total broadband customers increased from 279,000 at the end of March 2005 to 302,000 at the end of June 2005. In the third quarter of 2005, Sonera launched 'ADSL 12 Mbps' and 'ADSL 24 Mbps' which sped up to 24 Mbps. It also reduced the monthly rental prices for all its services in Helsinki and Alastaro regions by up to 33% in its business grade.

Elisa
Elisa is a telecommunications service provider in Finland, and has international presence with a focus on the Baltic rim.
Elisa's total broadband subscribers increased from 308,183 at the end of June 2005 to 345,898 at the end of September 2005.

Auria
Auria is operator which is wholly owned subsidiary of TeliaSonera Finland after its acquisition in September 2003. The company had 13,000 ADSL subscribers at the end of December 2003.

6. Theory of Bundling

According by Kottler (Kottler 2002), sellers often bundle their products at a set price. An auto manufacturer might offer an option package at less than the cost of buying all the options separately. For example company might offer broadband connection and internet security software together at lower price than the cost of buying them separately. Since customers may not have planned to buy all of the components, the savings on the price bundle must be substantial enough to get them to buy the bundle.

Some customers will want less than the whole bundle. Suppose telecommunications operator offer include free delivery and training. A particular customer might ask to forgo the free delivery and training in order to get a lower price. If the customer is asking the seller to "unbundle" its offer, the seller could actually increase its profit by unbundling. He saves more in cost than the price reduction that he offers to the customer for the items taken out. Thus if the supplier saves 100 by not supplying unwanted delivery and it reduces the customer's price by 80, the supplier has kept the customer happy while increasing its profit by 20.

7. Service Bundling

Service providers can increase their subscriber revenues by bundling services and by offering differentiated service levels through Service Level Agreements (SLAs).

DSL bundling helps companies reap the benefits of dramatically lowered WAN costs, improved global connectivity, and high reliability, while providing sufficient bandwidth. It also helps to combine such critical traffic as voice and video with data.

Bundling VoIP (Voice over IP) or TV/IP with ADSL service is becoming constantly more popular. Internet service provider tries to sell cheap long-distance service. Providers try to grow their profits by bundling cheap voice services with more expensive data services.

These plans are good for their businesses. They also can be good for consumers. Reports tell of local phone bills being halved and high-speed Internet access being given away for free. These deals seem to be designed to get you into buying costlier services such as videoconferencing and hosted software applications. Their sales team will try to get you buy their other services. Service providers approach you with a variety of Web-related services such as managed e-mail, site hosting, and secure, Internet-based networks. It is not necessarily bad thing, just possibly more costly, they have to get their profits from somewhere. So once you

subscribe to two or more services, you're less likely to change service provider. And once you're locked in, they hope to sell you higher-priced data communications services. (Kevin Fergoson 2002)

If you opt for bundling, you should read the SLA (service level agreement) guaranteed by your contract. The SLA has specifics like which provider is responsible for what. Who drops the bill if you lose service? Of course many SLAs offer compensation only for hourly online charges, not the lost sales.

Independent providers
On the other side there are VoIP service providers such as Vonage and Skype who have changed the competitive landscape by adding a number of calling features and capabilities under flat-rate monthly plans. They are offering videoconferencing and phonecalls over Internet. VoIP (Voice over IP) services typically promise a smaller phone bill, virtually wiping out charges for long-distance and international calls.

They bring to customer freedom of choise and also smaller bill for their calls. On the other hand their services can differ dramatically in price or quality. Many subscribers of different VoIP services can't talk to each other. There is no technological obstacle as to why VoIP providers are like little islands. They must share their customer information to connect with another VoIP provider's customers. That is why VoIP carriers are overprotective and act like little fortressess.

8. Bundling Mobile and Triple-play Services to ADSL

Bundling has become the key to many telecom operators growth strategy. Broadband users, whether they are home users or corporate customers, are more likely to have wireless phones. This represents a competitive threat to cable operators who have to respond with their own bundled wireless offering or they risk losing valuable customers. So, the next step in bundling is to combine broadband, particularly ADSL connections, with mobility and get rid off cables. It combines two essential networking functions broadband access to Internet and staying mobile. (Amol Joshi 2004)

Triple-play bundles packages consisting of phone, cable TV and high-speed Internet. "Triple-play bundle packages allow residents to have high-quality services and provides low costs by bundling the service for a price that is less than the price of individual services," said Tim Lebel, Arialink Broadband's vice president of operations in Lansing Michigan.

While ILECs (incumbent local exchange carriers) strength lies in traditional voice services and the ability to add a wireless technology in the bundle, triple play offers MSOs (multiple system operators) the opportunity to use their better video position, and combine it with broadband Internet and new voice services. With a good network in place, MSOs also have better starting point for services such as video. ILECs will have to focus on bundling and innovative price cutting tactics, wireless services, and integrated home/work offerings that could give better boost to their corporate customer relations. (Frost & Sullivan 2004)

9. Influence of Triple-Play

Triple play strategy that bundles voice, video, and data services can be a key determinant of the consumer's final choice. The Triple Play comes with the promise of increased profits and customer loyalty. It doesn't come without the risks. By adding more complexity it could end up taxing resources, dragging profits down and ultimately creating more customer churn in the end. That is why for telecommunications carriers and cable service providers who are thinking of adding Triple Play technology to their networks, the idea seems more like Pandora's Box than low-hanging fruit.

The service that will make triple play stay is broadband TV, and this is starting to influence the broadcasting industry. Broadcasters have been slow to embrace these digital technologies. They have feared that this would bring more competition by opening new market, but digital broadcasting has more to do with access to new services than developing new content. It allows access to the emerging IP-based broadband services. Now, a lot of new digital broadcasters are rapidly moving into the broadband areas and telecommunications in general.

Governments around the world are unable to elicit significant public interest in broadband, digital TV after legislating for the transition from analogue to digital TV. Most models are based on the old broadcasting model and very few viewers so far have been prepared to pay big money for more of the same TV.

The disappearance of VCR and the birth of the DVR have increased demand for better user experiences. The birth of these new services, have driven customers away from PCs towards plasma screens and HDTV. This can increase customer loyalty significantly.

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MEDIA CENTERS

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Abstract

The aim of this paper is to discuss the current state of the media center concept, view the possibilities and problems it creates and analyze the business situation between different vendors.

The paper is divided into five sections. The first section is the introduction that describes the general concept of media center: what it is and what it does. The second section covers the technology and standard issues related to the topic. In the third section we look at the possibilities and risks the media center product brings from the perspectives of end users, vendors and content providers. The fourth section is dedicated for the current vendors and their products in the market as well as the business strategies used. Finally in the fifth and the last section we summarize the ideas and draw some conclusions based on them.

Key Words

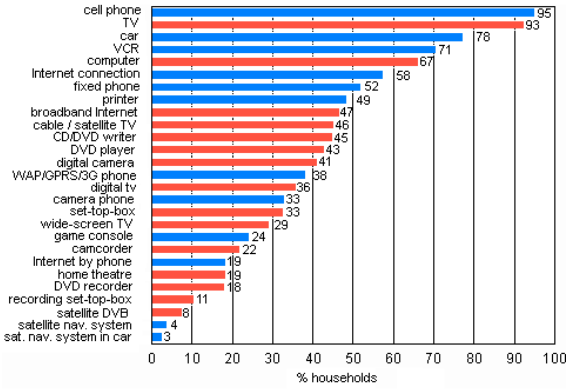
Media Center, Media Center PC, Home Entertainment

1. Introduction

In the today's world the digitality has become a widely accepted characteristic of information. All the common types of media such as music, video, books, magazines, TV and radio broadcasts and photographs, can be used in a digital format for storing and reproducing. At the same time the technology that is used for the different types of digital media has developed fast. The price-quality ratio that consumers are getting now for their electronics products is good. Digital cameras, mass storage devices, broadband Internet connections, digital televisions and digital music players, they all can be bought with reasonable prices.

This is also the reason why consumers are interested in buying electronics goods. The figure 1 (Tilastokeskus, 2005) shows the percentage of consumers owning electronics products in Finnish households in November 2005. The relevant products are painted in red. Finland is just one of the developed countries with such a phenomenon so the picture clearly shows there is a demand for entertainment products and an integration of different technologies.

Figure 1: Electronics goods in Finnish households (Modified from Tilastokeskus 2005)

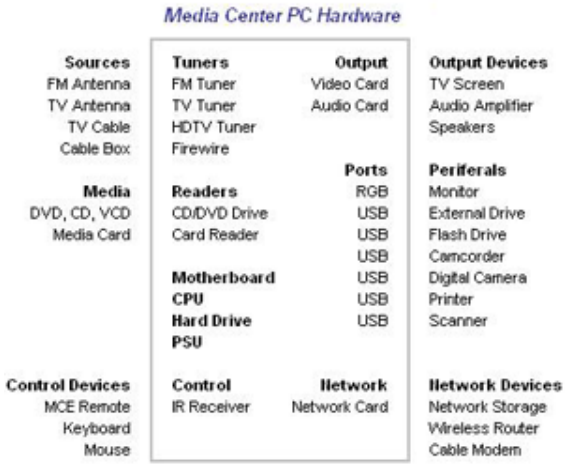


Media center is a concept that tries to integrate different media technologies into one system. It joins the most common media devices like digital television and radio, CD and DVD player, digital music and video players, digital photographs and Internet browsing, and offers a common user interface to control them. Through this interface you can watch and record TV programs, DVDs or digital videos, listen to your own music from CDs or hard drive, browse Internet or make a slideshow out of your photographs as few examples. Media center is very much like a powerful multimedia PC with TV and graphics card, CD/DVD player, audio card and mass storage devices; in fact it runs on PC hardware. But in addition it also has to be stylistic and well-designed because the environment in which it is to be used is normally the living room.

2. Technologies and Standards

The media center system can be divided into two subsystems: the hardware inside the box and the software running on a supported operating system. The hardware provides the basis and the capabilities for the system. Figure 2 (BuildMediaCenter.com, 2005) shows the main hardware parts and connectivity that a media center should include. The most important parts are the TV tuner card, the video card and the audio card because the system must be able to handle well the processing of audio and video as well as the TV network signal decoding.

Figure 2: Input and Output Devices of Media Center (BuildMediaCenter.com 2005)



The software can be either separate product that is being sold commercially or distributed freely as open source project, or it can be integrated into the operating system as is the case with Microsoft's Windows XP Media Center Edition.

The different areas of hardware and software technologies are explained more in detail in the following sections.

2.1 Central Unit

The core and shell of the system must be powerful enough for multimedia processing yet silent and stylish enough to fit into living room. The motherboard and the CPU must offer processing power and connectivity for the rest of the system. For the case there are a number of vendors selling silent and stylish solutions that fit the needs of a media center system.

2.2 TV and Radio Tuner

There are a variety of different standards and technologies related to TV tuner cards that have to be considered with a media center. The card can support analog, digital or both signals. In media centers the TV card should be digital to be able to utilize the capabilities of digital TV network. Other important considerations are whether the card accepts the high definition (HDTV) or standard definition signal, what are the digital media formats (MPEG2, MPEG4, etc.) supported and is there a hardware encoding possibility to free up CPU usage.(Ludington Media Inc, 2005)

Some of the cards have a radio tuner integrated into them for radio listening capabilities.

2.3 Sound and Video

The sound card should have at least few analog inputs for audio sources such as microphone, and few analog and digital outputs for the speaker system. Depending whether there is a separate surround amplifier or not, the card might also have Dolby and DTS decoders.

The video card also plays an important role in the media center. It processes the video media that can be in different digital formats (DivX, MPEG, WMV, etc.). It is essential that the card has plenty of processing power so the CPU is freed up for other purposes and that the cooling system's noise level doesn't break the usability in living room.

2.4 Media Readers and Storage

The current common standards for media storage are CD, DVD and normal hard drives. In addition to these there are different kinds of memory sticks which are used for temporary storage. The media center must have a CD/DVD-player in order to support the DVD-video and CD-music playing. Preferably the player should be able to write also. Memory stick readers are an additional feature but not vital for the system to function. Hard drive is required in a system with PC architecture. In the case of media center the hard drive needs to be very big, as much as 200GB or more, for video recording and media storage reasons. Fortunately the price of mass storage devices has gone down.

Again the noise level of these mechanical devices affects the usability of the system in practice. It should be taken into consideration in a system.

2.5 Networking and Connectivity

In order to utilize fully the services offered in the Internet the media center must be connected through a broadband connection. Slower connections decrease the usability level of the system and should be considered carefully. For the connectivity inside home to other computers a wireless router is the best option. Media centers normally support streaming data from other devices over the network.

As what comes for the peripheral connectivity (digital cameras, printers, scanners, external drives, etc.) USB and FireWire ports are most useful. So the media center should have additional ports to be used for connecting temporarily used devices.

2.6 Control

Since the media center system is based on normal PC architecture and has an operating system on which the media center software is running the user will need to be able to control all this. For simple menu navigation a remote control is sufficient but for more profound control a keyboard and a mouse is necessary. Keyboards and mice come out today in wireless versions using radio frequency as the transmission media. The remote control uses either infrared or radio frequency technology. The support for different remote controls depends on the operating system and the media center software used.

2.7 Output Devices

The media center outputs basically two kinds of media: voice or music and pictures or video. Therefore the two types of necessary output devices are screen displays and audio systems. The screen displays can be normal or flat TVs, computer monitors, flat screen displays or even small touch screens.

The audio system can be as simple as a pair of speakers or it can be a full home theatre system that uses the digital signal from the media center and decodes it for the surround system.

2.8 Software

On top of the hardware there is a normal PC operating system running. In most cases it is a Microsoft Windows XP but there are also some media center solutions which use Linux. The media center software then runs on the operating system in question and implements all the services that the media center offers. Depending on the vendor or the developer there are solutions which are either commercial products or open source projects.

2.9 Dominant Design

The concept of media center PC is still rather new so the market is still in a turbulent phase with different product designs. Yet there seems to be emerging a dominant design and with it more big players are entering the market (ETH, R. Boutellier, 2005).

The current solutions from ready-made media centers all seem to be concentrating in usability of the product; the design is stylish and quiet. The most common software solution is the Microsoft's MCE.

The MCE operating system puts some limitations requirements on the hardware side because the components must be compatible with the MCE. The normal common solutions include digital and analog TV tuning service, music playback through CD, DVD or digital format (mp3), video playback through DVD or digital format (avi, mpeg2, wmv), digital picture viewing, audio, video and peripheral connectivity, networking capability, mass storage of at least 250GB and remote control system. These services and technologies seem to be in almost all of the products. The amount of other services depends on the producer and the price level of the product, whether it is a high-end or a low-end solution.

3. Possibilities and Risks

The media center offers different kinds of possibilities for different players depending whether we look at the concept from the end user, vendor or content provider perspective. The end user is the consumer that uses the product in his home. The vendors can be divided into two groups, hardware vendors and software vendors. The content provider in this case means media publishers, movie and music producers and so on. When discussing the possibilities we consider also the risks that are included with the technology.

3.1 End Users

The end users' possibilities are related with the user experience the product offers. Media center as such doesn't really offer any new technology; it just combines the commonly used technologies and makes the user experience qualified for living room. The most basic services are TV and radio watching and recording, CD and DVD playing and recording, digital music and video playing from hard drive and digital photograph management and watching using slideshows. This all sounds trivial media management that can be done with a multimedia PC. It is true but media center pushes the concept into everyday life and tries to make the usability as good as possible. So the user doesn't necessarily have to be a techno-freak to be able to use a media center.

As an example of a use case with media center could be a scenario where a couple is watching television and the woman wants to look at a soap opera. The man is not really interested in that but wants to see a documentary from another channel. With the media center he can record the documentary into the hard drive of the media center while his wife is enjoying the soap opera. Also his wife can "live pause" the program for a short break and then resume it some minutes later. In general the possibilities of TV watching and recording are very much the same as with a DVR

The other capabilities of the system such as music or video playing and management, digital photo management, Internet browsing and email reading are similar to the ones that can be done with normal computer but again media center relies to easy usability and living room experience. You don't need to have different devices for different purposes when the media center system combines them all into one product.

As a result of the combination there are certain risks involved for the end user. Since the user agrees to use the technologies and standards the media center supports he might get locked into those. It depends much on the type of media center whether it is commercial or open source and how it is being supported. Let's think about an example from the end user perspective. If the user has bought a commercial media center the vendor of this product might not want to support his competitor's standards. This is a risk for the end user but a possible strategy for the vendor.

The end user must also be a little techno-oriented if he is not to buy a package solution. He has to consider the type of the TV network and the internet connection, if he wants to use a home LAN to connect other computers and devices. He also has to make sure the media center software really supports the hardware he

will be using. In ready-made package solutions there won't be such problems but the product might be more expensive and not exactly what the user wanted.

3.2 Vendors

Vendors orientating in special hardware like TV tuners cards, remote controls and specially designed cases will get grow their market share if the media centers will get popular. Also the vendors selling ready assembled solutions will get new products in their product portfolio, so called media center PCs. There will also be demand for media center software with good usability and support

However both the hardware and software producers have to consider the current standards and trends in the information technology to avoid supporting standards that won't get them anywhere.

3.3 Content Providers

The concept of having your music and video media stored in digital format on a computer brings up new business models for the content providers. The big and cheap mass storage devices change the way of thinking about media library. In future it might not be a bookshelf full of CDs and DVDs but rather a digital library managed automatically with the media center computer. This would require new channels for providing the content. With digital music this is already the case in today's world but the digital video, a DVD movie for an example, requires so much data that delivering it over the network is not practical. This brings up the copyright issues which have to be considered also.

In any case there is a demand for this kind of business model for providing the content if the technical problems with availability and digital rights management can be solved.

4. Vendors and Strategies

The media center software producers can be divided into commercial vendors and open source developers. The most common platform that is used by the producers is the Microsoft's Windows XP operating system. There are also few developers, both commercial and open source, making products for Linux systems. In the following sections we look more in detail some of the vendors and their products.

4.1 Commercial

Microsoft

Microsoft is one of early entrants in the slowly emerging markets with its media center and operating system bundle, Windows XP Media Center Edition. It has come out with a new edition of the system each year ever since the first edition in 2003. The company claims to have sold four million licenses by the end of 2005 (NewsForge 2006).

The newest edition (2005) has all the functionalities discussed in chapter 3.1. It also offers extenders, sort of plug-ins, for the media center system to better the connectivity (Microsoft Corporation 2006). Microsoft relies its strategy in partner deals. It sells most of its media center licenses through vendors like HP and Fujitsu Siemens who sell hardware and software in bundles, installed and ready to be used (NewsForge 2006). The price of Windows Media Center XP OEM license is a bit over 100 (MBNet 2006).

Apple

Apple's current solution for media center is the recently released Mac mini. It offers all the services that were discussed in chapter 3.1 but TV tuning. This is a disadvantage for Apple although it tries to compensate with other abilities like neat size, familiar Apple-design and compatibility with other iSuite technologies. Clearly Apple tries to differentiate with its brand, design and known quality. The price starts from $600 and it includes the box and the software running in it.(Apple 2006)

SnapStream

SnapStream is selling a media center software bundle for Windows XP operating system. Its Beyond Media and Beyond TV 4 / Link products offer together the same services as Microsoft's Media Center Edition. The company is selling the product alone (around $70), in bundles with TV tuner and other accessories (around $150) or as subscriber licenses for partners selling media center hardware.(SnapStream 2005)

Meedio

Meedio is offering its digital media center and digital video recorder solutions in Meedio Pro package for Windows XP systems. Meedio Pro offers the same services as the other vendors' products but it tries to differentiate offering an extension named HouseBot that offers access to control household appliances such as lights and A/V equipment through the common user interface. Meedio Pro solution costs around $45 and there is a 15 days free trial period. Hardware vendors are also selling it bundled with their products.(Meedio LLC 2005, Okoro Media Systems 2005) The latest news is that Meedio was acquired by Yahoo! and they will continue the development process of the software. It will be interesting to see what kind of position will Meedio get in Yahoo!'s strategy(Meedio LLC 2006 Newsletter).

SageTV

SageTV Media Center is a commercial software available for Windows XP and Linux platforms. It offers also the same services as the other vendors' solutions. The price for SageTV Media Center is $80 for both Windows XP and Linux. SageTV product can be found also bundled in ready-built solutions.(Okoro Media Systems 2005, SageTV 2005)

4.2 Open Source

MediaPortal

MediaPortal is a free open source project to develop media center software for Windows XP platform. The software offers all the services we discussed in chapter 3.1 including a weather report service that uses Internet to gather the needed information. The software is completely free which is appealing for a consumer but then again it raises questions about support issues.(MediaPortal, 2006)

MythTV

MythTV is another free open source project to develop media center software but it runs on a Linux platform. The services it offers are similar to the ones that MediaPortal offers. Again the price tag of zero bucks is appealing but for an average or even a bit techno-oriented user it is not a good option. There is some support in the forms of documentation but you really need to know what you are doing.(MythTV 2006)

4.3 Success Factors

There are several factors that are playing a part in the success of media center technology. Some important ones that should be taken into account are usability, services offered, upgradeability and connectivity, compatibility and of course price.

Usability is the most important of these factors. Since media center is supposed to be a living room technology there is no room for complexity and disturbing side effects like noise. To compete with other living room products it should work like a plug-and-play device without any complicated configuration hassle. Also the user experience with different services should be straight-forward and easy to use to wake the interest of the average consumer.

The current services offered is not necessarily enough to weight the scale for media center when comparing it against other home entertainment products. The number of the services offered is not so important as the quality and seamless integration of these services in order to construct a good user experience. A killer service might make a difference for the consumer to buy the product but it is yet to be seen.

The possibility to upgrade the hardware or the software comes to play a role when there are new standards emerging in the media technology. It is not really practical if the consumer is forced to buy a new product whenever there is a small or bigger technical evolution. As an example we can consider the new generation of media storage discs, BluRay and HD-DVD. The current media centers don't support these standards yet so it should be made easy to upgrade the systems both from hardware and software point of view. The aspect of connectivity relates to the upgradeability. The media center should offer a possibility for the user to extend his system with other peripherals easily.

One important factor with media centers is their support for different standards, in other words that they are compatible with different technologies. The software and hardware vendors have to take into account that standards differ in different parts of world. The digital TV network is a good example of this.

Finally the role of the pricing: the software only products don't differ so much in price so the price has a smaller effect on their success. On the opposite the ready-to-be-used bundles of software and hardware are more price sensitive. It has a big difference if a Mac mini costs $600 and a normal media center pc with bundled software over $1000 even though the Mac mini needs an extension for the TV tuner capability.

5. Conclusions

As the technology advances fast in the field of multimedia there can be seen demand growing for a single system that manages all the different media at home. In the past years there have been solutions for the media center concept but the consumers didn't pick it then. The reasons were in the poor quality-price ratio. Now the prices have gone down for the media center hardware and software and it seems the consumers are starting to pick it up. A Microsoft executive exclaimed in a news bulletin in March 2006 that the sales of Media Center Edition platforms exceeded the sales of the standard edition of Windows XPs in February 2006, and that the number of sold Media Center Editions reaches 10 million by the end of March 2006(CNet News.com 2006).

With the demand increasing and dominant design emerging it is important for the players to come out aggressively with their products if they want to participate in sharing the market and revenues. Microsoft seems to head towards the mainstream consumers by selling their product through partner licenses. Apple will try to grab its share with the high-end design and compatibility with other iSuite products. The other players will need to differentiate either with quality or price. The brands of Microsoft and Apple are rather strong to fight against.

In the end it is the consumer that decides who will win if anyone. Even though there is demand and media centers are being sold it is important that the vendors consider the success factors mentioned in the previous chapter, especially the usability. All of the factors will play the final role in the competition for the consumers' interest and success of the technology.

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REGULATION AND DEREGULATION OF ROAMING SERVICES

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Abstract

The aim of the paper is to discuss various aspects of roaming services. The prices of roaming services have maintained in Europe their high levels, but they are declining. European Commission (EC) thinks something needs to be done. EC has launched a second phase of a public consultation on mobile roaming services. In July 2006 proposal for a regulation is intended to be forwarded to the European Parliament (EP) and Council. The GSM Association (GSMA) is very skeptical about the need for regulation. The paper is divided into eight sections. In the introduction part a short view to the field of roaming is given. In addition, regulation, deregulation and the situation in Europe are shortly discussed. The second section is about the importance of roaming to the revenue flows of operators. Then pricing and marketing practices of roaming are discussed. Fourth section is about roaming contracts between operators, which is followed by influence of international consolidation of operators. Next the impact of few services to roaming is been examined. The seventh section discusses how to regulate or deregulate roaming in Europe more efficiently. Finally, we draw the whole picture together and give some conclusions.

Key Words

Regulation, Deregulation, Roaming

1. Introduction

Roaming is defined as the ability for a cellular customer to automatically make and receive voice calls, send and receive data, or access other services when traveling outside the geographical coverage area of the home network, by means of using a visited network. In technical terms, roaming is supported by mobility management, authentication and billing procedures. Roaming agreements are the basis of establishing roaming between network operators. In addition, commercial terms are contained in these agreements (GSMA, 2006b).

There are different types of roaming. National roaming means visiting a network, which is in the same country as home network. When the visited network is outside the home country, we speak about international roaming or sometimes global roaming (GSMA, 2006b). Different types of roaming are also based on technologies and services. These are e.g. GSM roaming, GPRS roaming, SMS roaming and MMS roaming (Tallberg Mathias, 2005). The role of MMS among other services is examined in the sixth section of this paper.

One of the key reasons for the global success of the GSM is GSM Roaming. It enables to have a single number, a single bill and a single phone with worldwide access in more than 210 countries (GSMA, 2006b). As people are traveling more and there are about 2 billion GSM subscribers in the world, the role and importance of roaming is increasing.

The prices of roaming services in Europe have maintained their high levels. EC has been following roaming prices and is now planning to take action. A series of reports on the implementation of the EU regulatory framework for telecom services shows that consumers are benefiting from lower prices for fixed and mobile voice services. International roaming makes an exception and this is why EC thinks that a regulation is needed (EC, 2006). The consequences of the proposed regulation should be thoroughly studied before making big decisions. The proposed regulation has already faced resistance. GSMA is very skeptical about the need for regulation (GSMA, 2006a). We find it important that the matter is examined in detail. The opposite of regulation is of course deregulation. It is hard and important to find the right balance between regulation and deregulation. Wrong decisions could jeopardize the status of the European mobile markets. These questions are more thoroughly discussed in the seventh section of this paper.

2. Share of roaming traffic of operator revenue

According to GSMA, more than 6 billion roaming calls were made in year 2000. A research made in 2005 reveals that the number of international roamers will more than quadruple between 2004 and 2010. In 2004 the number of international roamers were 210,000,000 and in 2010 it could be as much as 850,000,000 (Mobile Europe, 2005). Operators earn about 10 billion euros in a year, because of the higher price of roaming calls (Yle Uutiset 24, 2006).

It is clear that roaming is big business for the operators. Share of roaming traffic of operator revenue should increase in the future. Airline ticket prices are coming down, which is boosting peoples' willingness to travel. According to Finavia, which maintains Finland's

network of airports and the air navigation system, the number of yearly international passenger has almost doubled from 1994 to 2004 (Finavia, 2006). International travelers at the airports of Finland in 1994 were under 4 million and in 2004 almost 8 million. It is not a surprise that same kind of findings can be found from other international airports. Life goes mobile as Nokia puts it. Mobile penetration exceeds 100% in some countries. People want to use their mobile phones when visiting other countries. The launch of new mobile services is also generating roaming revenues for the operators. The impact of some new services to roaming is discussed in the sixth section of this paper.

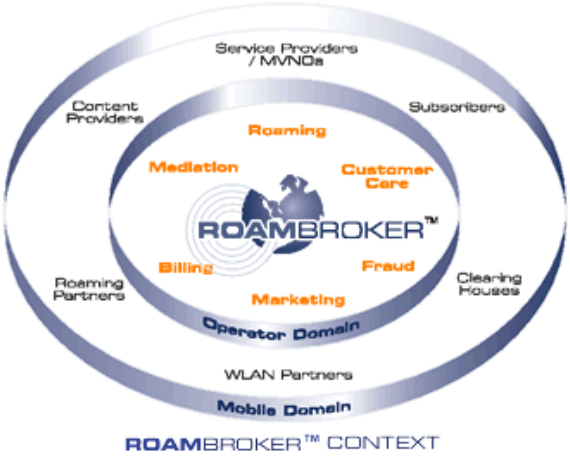
It is estimated that roaming services generate approximately 15 to 25 % of the total revenue for a mobile network operator (MNO) in Europe (The wholesale national market for international roaming; possible remedies, 2003). On the following, steps that can help operators to increase value generated from roaming are presented. Increasing the roaming population and coverage area naturally has a direct impact to roaming revenues. Coverage area can be broadened by new roaming agreements or by merging with other operators. It is also important to increase interoperability of access/core technology and services. Interoperability makes the coverage area larger or more users in the same area can be reached, because the networks can work together. Other steps are to increase the number of services offered, reduce transaction costs by adopting a clustered or centralized model, adopt simple and uniform roaming pricing models and finally enable inter-access technology roaming by introducing multi-access mobile handsets (K. R. Renjish Kumar, Heikki Hämmäinen, 2004).

3. Pricing and marketing practices of roaming

Pricing and marketing practices of roaming have issues, which clearly need improvements. Roaming customers are now more demanding. They want greater transparency in roaming prices. The whole field of roaming is unclear for many consumers. The pricing practices of roaming are discussed next, followed by marketing issues.

3.1 Pricing practices of roaming

Pricing practices of roaming are still complex, but things are improving. The launch of new roaming services is also complicating the pricing. Mobile operators are constantly trying to find new and different pricing strategies. It would be interesting to study what would happen if there would be no roaming charges at all, but this kind of study is out of the scope of this paper. From the technical point of view, there are many companies, which offer different kind of roaming solutions for operators. Operators can centralize all their financial aspects of roaming in a single place. By buying these solutions from specialized companies, operators can achieve competitive advantage and flexibility (CAPE Technologies, Roaming Management, 2006). Operators are able to concentrate on their core businesses and so their limited resources are used more efficiently.



Picture 1, RoamBroker ™ Context

When you make and receive calls while roaming, the visited operator keeps a record of your calls and other services used. These records and other charges are sent to the home operator by the visited operator. The home operator then converts the charges to the home currency and sends the bill to the consumer. It is important to notice that it can take some time before the visited operator sends the charges to the home operator (GSMA, 2006b). This is how the billing of roaming services works on a general level.

Roaming prices depend on three things: the home network, the visited network and the destination of the call. This means that there are thousands of possible variants of international retail roaming charges in Europe alone (GSM Europe, 2003). GSM Europe developed a voluntary Code of Conduct (CoC) for European operators. As said, consumers are demanding greater transparency in international retail roaming prices. The level of service transparency varies depending on the roaming agreement between the home and visited network operators (Ralli Timo, 2006). The goal of the CoC is to provide better information to consumers. This information is about choosing the roaming network, charges, availability of data services, prepay, specific value-added services (voice mail, access to customer care, recharge of prepaid, breakdown service, travel service, medical helpline etc.), coverage information and information on how to use roaming services in general (GSM Europe, 2003).

Many operators have already launched single-rate, zone-based roaming tariffs. The purpose of these kinds of tariffs is to simplify operators' offerings. All operators in the UK, Spain, Portugal and Italy now offer single-rate, zone-based pricing. Some operators in Belgium, Denmark, Finland, Germany, Greece and Netherlands also offer the same kind of pricing practice of roaming services (GSMA, 2006a). Some operators

charge monthly fees, which reduce roaming costs. The finding of the best deal is left to the consumer. There are also minute bundles that allow roamers to benefit from special discount prices. Some say that these new kind of pricing practices do not bring anything new. In our opinion, these new practices are a step forward.

This paper is more from the consumer point of view. It is possible to separate between consumer and business users. We believe that operators could increase their revenues from consumers roaming in foreign countries. Business users use roaming services, because they do not have a choice and they are not paying their bills. Consumers are often too afraid to use roaming services, because they do not know what it costs and they find other ways to communicate.

3.2 Marketing practices of roaming

Marketing of roaming services could be better, but we have to admit that things are improving. Nevertheless, roaming customers very seldom know how much roaming costs. It is argued that only 10% know what it costs to use mobile phone abroad (Taloustutkimus Oy, Kuluttajavirasto, Viestintävirasto, 2005). Detailed information about the prices can be found from the operator websites. At the GSMA website, it is possible to find the roaming partners of each operator and the type of services offered etc. So detailed information exists, but how many average mobile phone user surfs to the GSMA and network operator roaming and other websites? Europe's Information Society has a good information package about the different issues related to roaming in the Web (Europe's Information Society, 2006). Information about the pricing of roaming services is mostly received from the mail sent by the operators (Taloustutkimus Oy, Kuluttajavirasto, Viestintävirasto, 2005). In Finland Ficora and Consumer Agency would like to see the awareness of roaming prices among consumers increasing. More information about how to save in roaming charges is also needed (IT viikko, 2006). It is extremely important that consumers will find the existing information and that the amount of information increases.

When a mobile phone user is roaming in a foreign country, it is not always clear what network should be chosen. Some roamers do not even think about different issues related to roaming. Often a network is chosen automatically, but e.g., when a certain service is not working, another network might be chosen. According to a study, 80% of roamers use the network, which is automatically selected by the mobile phone (Taloustutkimus Oy, Kuluttajavirasto, Viestintävirasto, 2005). The same study shows, that people are satisfied to the functionality, but very unsatisfied to the price levels of using mobile phone abroad. Unsurprisingly many people use SMS and MMS messages instead of voice calls while abroad, in order to reduce roaming charges, but 33% do not try to save in roaming charges. These are just few issues, which the marketing people of operators should think. We believe that operators could increase their roaming revenues, if the obstacles mentioned earlier would be solved.

4. Roaming contracts between operators

According to GSMA, operators have more than 20 000 roaming agreements and growing. Elisa has roaming partners in 160 countries, with 300 network operators (Elisa, 2006). Finnet has partners in 120 countries, with 200 network operators (Finnet, 2006). Sonera's customers can use their mobile phones in 172 countries, with 269 network operators (Sonera, 2006). Operators can differentiate them from their rivals by having extensive roaming agreements. If we think about Finnish operators, Elisa has more roaming agreements than others do, but Sonera leads in the number of countries, where their subscriptions work. As said, operators are constantly finding new roaming partners and new roaming agreements are quite common. Interestingly country specific factors like population, GDP growth and number of international travelers are not the factors when finding roaming partners, which matter the most. The mobile operator size, import and export figures are more important factors when finding new roaming partners (Rieck Olaf, Yinzhi Chen, Habib Haneesa, and Junzheng Xiao, 2005).

Roaming agreements are based on business issues. Operators are not forced into different kinds of contracts. Authorities monitor mobile markets constantly and sometimes disagreements need to be solved in the courtroom. Regulatory issues also affect roaming contracts between operators. When e.g. a roaming agreement generates too strong competitive advantage over rivals, competitive authorities would be involved. On the eastern border of Finland, the signal levels of Russian mobile operators have been too strong. Sometimes people living in the eastern cities of Finland notice that the network shown on their mobile phones is a network of some Russian mobile operator. Not always people notice this in time, but they will surely notice their increased phone bills. Finnish authorities have informed Russian operators. We will have to wait and see what happens in the future. This example illustrates how authorities monitor mobile markets and take action when necessary.

5. Influence of international consolidation of operators

Mergers and acquisitions (M&A) have been very common activities in the telecommunications industry. Alliances, fusions and purchases are almost a weekly phenomenon. 3G licenses cost a lot money and just recently 3G terminal bundling started in Finland. Consumers might not want to use or more importantly pay for the new services enabled by 3G. Telecommunications industry analysts predict that massive consolidation operations will become common. In the operator, industry consolidation should enable cost reductions and sharing. 3G is an important reason

for the increase of consolidation. Consolidation does not help the industry and the operators automatically. Consolidation and integration need to be well managed (Springham Justin, 2002).

Consolidation could have an impact to roaming. When telecommunications companies merge and form alliances, huge companies like Vodafone and Deutsche Telekom are born. There are discussions whether the increased consolidation could enable operators to establish a global billing architecture for all their individual operations (Springham Justin, 2002). This would certainly simplify roaming billing processes. The possible increased cost efficiency among operators could have an impact on the international roaming charges. In addition, the role of roaming agreements between operators is also affected. If the number of operators gets smaller and operators become bigger, it could reduce the need for roaming agreement negotiations. Consumers would benefit from broad coverage all over the globe. Vodafone e.g. is a huge company and their subscribers have good coverage almost anywhere.

6. Impact of new services to roaming

MMS is becoming more and more popular. When people travel, it is very common to send MMS messages to family and friends back home. MMS messages could shrink or is already shrinking the share of traditional postcards. MMS messages are much more interactive, because it is possible to get instant feedback on e.g. how lovely the scenery is in Greece. We believe that people would use these new services more frequently when traveling, if the prices are better known. It is also important that the services are easy to use and that they are working. Nothing is more frustrating than to send the same MMS message five times and not knowing what the costs are and/or will the recipient receive the MMS message. GPRS roaming architecture is important, because it is used in EDGE, MMS, and 3G networks and beyond (Pohjola, O-P et al., 2004).

Operators today mostly compete on value and quality in their core services. Competitive advantage can also be achieved by offering innovative services in newer areas. According to GSMA, the mobile industry is defined by new services, new entrants and innovation (GSMA, 2006a). MMS, Internet access and broadcasting (DVB-H) are rather new services and they will definitely have an impact to roaming. 3G terminal bundling has just started in Finland, but has been going on in other countries for some time now. Terminals are improving and it enables the use of new and innovative services. Mobile-TV is a rather new service, but it is likely to be a real hit in the future. FIFA World Cup is held in Germany next summer. In some countries, it is possible to follow World Cup with your mobile phone. When e.g. mobile-TV services are used in a foreign country, roaming issues need to be taken into account. One important factor is what the roaming charges of the use of these new services will be. If the roaming charges of these services is high or remains high in the future, it is unlikely that consumers will actually use them while roaming in a foreign country. In the future operators need to find new ways to make revenue. The services mentioned will generate roaming revenues to operators, but sophisticated terminals, fast networks, efficient marketing campaigns and reasonable pricing practices are important factors and need the attention of operators.

7. How to regulate or deregulate roaming in Europe more efficiently?

European Commission is planning to regulate international roaming in Europe (EC, 2006). The EC's proposal for a regulation has already met resistance. The GSM Association is a significant opponent. GSMA represents 680 2G and 3G GSM network operators, regulators, manufacturers and suppliers. The members of GSMA have operations in over 210 countries. So clearly, GSMA's opinion is very central and powerful, but more views from other parties are needed.

The public consultation does not ask or provide any evidence of why or whether there should be regulation of international roaming. The GSMA also reminds that the EC should respect its own and the legally applicable processes. As already mentioned in the introduction, the EC should avoid the unwanted consequences of a possible regulation made in a hurry. These possible negative outcomes would have long term, negative effect on jobs, competitiveness and investment in the European telecommunications industry (GSMA, 2006a).

The big question is that whether the increased competition is enough to drive the international roaming prices down or is some regulation by the European Commission needed. What is the right balance between regulation and deregulation? The EC's viewpoint is aiming for greater consumer surplus. Everything should be cheap, have good quality and be easy to use etc. Operators' positions would be harmed by the proposed regulation. Operators' investments would be dangerously harmed as well. Investing in innovations is one important way to differentiate from rivals in the mobile market. International roaming is not an exception (GSMA, 2006a). The continuous fierce battle in the European telecommunications industry is forcing operators to be highly innovative and to offer new services and different price tariffs to consumers. The proposed regulation would reduce the ways that operators can differentiate their offerings. Operators are benefiting from the increased number of international travelers and mobile phone users, but face challenges as users are starting to find and use different ways to reduce costs and also the general cost of telephony is declining (Sutherland Ewan, 2004). Voice over IP (VoIP), soft phones and voice over wireless LANs are also big challenges for operators.

8. Conclusions

We are living exciting times, if we think about the whole roaming business. Consumers are demanding more and their awareness of the issues related to roaming is constantly improving. The European Commission is not happy with the price levels of roaming services. Still retail roaming prices declined 8% last year and the industry is delivering sustained value to consumers (GSMA, 2006a). European mobile markets are highly competitive and any regulation could seriously harm the entire telecommunications business. The European Commission should understand the nature of European mobile industry. It is very large and complicated ecosystem. It is also important to understand that international roaming is not a stand alone service. Very thorough studies are needed before any regulation is accepted.

Our opinion is that the market forces of highly competitive mobile markets in Europe will continue to push the price levels of roaming services down. Operators are starting to offer different kind of roaming packages and some operators have a lot of roaming information on their websites. Operators are focusing more on simplicity, transparency and value. We believe that the ongoing discussion, increased consumer power and demands, intense battle between operators, the launch of new services, European Commission's proposal for a regulation and the GSM Association's response to the proposal are very important and fruitful to the roaming business. It is important to notice that European Commission and the GSM Association both have their own goals. It is crucial that also other important parties express their views, which should encourage discussions even further. Regulation and deregulation are the opposites of each other. Finding the right balance between these two is extremely important. With right decisions and favorable developments, the outcome and the future of roaming will be bright.

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RADIO SPECTRUM POLICY IN EUROPE

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Abstract

Radio spectrum is a valuable and scarce resource, and therefore has to be managed and coordinated carefully. Spectrum management and policy is currently facing new challenges, as the rapid development of radio technologies is opening up possibilities for new and advanced applications and services.

Spectrum policy in Europe has been traditionally based on a so-called "command-and-control" approach, where government institutions decide both on spectrum allocation and assignment, i.e. which services and technologies are allowed to be used, and who has the rights to utilize the bands. Currently, there is an active discussion going on about the benefits and drawbacks of introducing more market-based approaches to spectrum management. In these approaches, spectrum licensed could be traded, and the spectrum licensees would have more freedom in choosing which services to provide and which technologies to utilize.

Transition from the command-and-control approach towards a market-based approach should happen in stages, and care should be taken not to lose the benefits of the current system in the process. Furthermore, the choice between the regimes is not black-and-white; there are many different parameters that can be decided on independently. Especially, spectrum trading and service/technology neutrality issues should be discussed and decided on independently from each other.

Key Words

Spectrum management, Spectrum policy, Spectrum trading, Innovation, Competition, Europe

1. Introduction

Radio spectrum is a valuable resource and a pre-requisite for all wireless communication systems, including e.g. radio and television broadcast systems, mobile networks, satellite and radar systems, and fixed radio links. It is estimated that the economic value generated for consumers of services derived from radio spectrum is around 2% - 2.5% of EU's gross domestic product (GDP) (Analysys 2004). Mobile communication and broadcasting services are the most important from this perspective, and according to a Danish study (Falch & Tadayoni 2004) account for 85% of the total contribution to GDP.

Radio spectrum is also a scarce resource. The use of radio frequencies must be regulated to ensure that there is no interference between different systems and users. Although the utilized radio spectrum spans from around 10 kHz up to 100 GHz and above, only a fraction of the frequency bands are in practice usable for e.g. mobile communication systems. As the frequency increases, the achievable link lengths decrease and requirements on e.g. the line-of-sight conditions between the communicating ends become stricter. Higher-frequency systems are also more expensive. Thus, today's mobile systems are operating around 0.5 - 2 GHz spectrum bands.

The rapid development of new radio technologies has resulted in a number of new systems being introduced to the market. In addition to third generation (3G) mobile systems, digital television systems as well as broadband wireless systems such as WLANs and WiMAX are being deployed around Europe at an increasingly fast pace. In the future, the number of different radio systems and standards is likely to increase further, putting pressure on the flexibility and adaptability of the spectrum management process.

The current development regarding radio spectrum policy in Europe is based on the Radio Spectrum Decision (European Parliament 2002) and the Radio Spectrum Policy Group Decision (European Commission 2002) which established the Radio Spectrum Committee (RSC) and Radio Spectrum Policy Group (RSPG), respectively. The RSC provides the European Commission with advice on technical implementation measures, while the RSPG provides advice on policy and strategic issues. The Radio Spectrum Decision also established a policy and legal framework for radio spectrum issues in the European Community.

The most recent report on the activities undertaken under the RSC states that "*current inefficiencies in the distribution and use of spectrum create costs, lead to wasted opportunities for business and reduce the take-up of innovative services to the detriment of consumers*" (European Commission 2005). Efficient spectrum policy is clearly seen as important for the innovativeness and competitiveness of Europe as whole.

The purpose of this paper is to introduce and compare different spectrum management approaches, and to recognize their potential impacts on the European markets. The focus is on mobile and broadcasting technologies and services, and on the different options of market-based spectrum management approaches.

2. Radio Spectrum Today and Tomorrow

In all markets, spectrum allocation is very fragmented, with several hundred different uses allocated for the frequencies between 3 kHz and 300 GHz. However, as the primary focus of this paper is on mobile communication and broadcasting systems, this general overview of spectrum usage will focus on the frequency ranges used by these technologies, VHF (30-300 MHz) and UHF (300-3000 MHz).

2.1 Spectrum for Broadcasting

The frequencies used for analogue television broadcasting in Europe today were originally allocated in the European Broadcasting Conference held in Stockholm in 1961 (hereafter ST61). The revised ST61 frequency plan allocated five bands for television broadcasting, divided into 8 MHz wide channels, as listed in Table 1 (Hai 2004).

Table 1: Revised ST61 frequency bands

Freq. band	ST61 band	Freq. range	Channel #
VHF	Band I	47 – 68 MHz	2 – 4
	Band II	87.5 – 100 MHz	
	Band III	174 – 230 MHz	5 – 12
UHF	Band IV	470 – 582 MHz	21 – 69
	Band V	582 – 862 MHz	

Finnish analogue television broadcasts use bands III – V, whereas digital television broadcasts are limited to IV and V (Finlex 2002).

The frequency band 87.5 – 108 MHz was allocated to FM radio in Geneva, 1984 (Hai 2004).

The Regional Radio Conference, set to be held in Geneva during May and June 2006, will re-evaluate the spectrum requirements for broadcasting in light of the new features and possibilities of digital broadcasting, resulting in a new plan to replace ST61. Due to the increased efficiency in bandwidth utilization by digital systems, up to six channels, multiplexed into one signal, can be broadcasted in the same amount of spectrum as one analogue channel (Burns 2004). The forthcoming conference will also address the length of the transitional period; CEPT wants to end analogue broadcasts by 2015, but Russia and the Arab countries have proposed later dates (Kangas 2004).

2.2 Spectrum for Mobile Communication

Mobile communication technologies currently used in Europe are GSM, UMTS and TETRA. A recent development is the deployment of a Flash-OFDM network in Finland, using the frequency band left empty by NMT 450. WLANs providing more limited mobility can be deployed in the 2.4 GHz and 5 GHz unlicensed frequency bands. Furthermore, WiMAX networks are being made available all over Europe. The frequencies used by these systems in Finland are listed in Table 2 (Finlex 2002, Finlex 2006).

Table 2: Frequency bands allocated to mobile and portable communications in Finland

Technology	Frequencies
GSM	880 – 915 MHz 925 – 960 MHz 1710 – 1785 MHz 1805 – 1880 MHz
UMTS	1900 – 1980 MHz 2020 – 2025 MHz 2110 – 2170 MHz
TETRA	380 – 386 MHz 390 – 396 MHz
Flash-OFDM	453,700 – 456,925 MHz 463,700 – 466,925 MHz
WLAN	2400 – 2483,5 MHz 5150 – 5350 MHz 5470 – 5725 MHz
WiMAX	3410 - 3590 MHz

2.3 The Digital Dividend

Digital Dividend (or *Spectrum Dividend*) is a term coined to describe the frequencies left unused after the transition to digital television is complete and analogue broadcasts are shut off. The spectrum required by digital television for an equivalent amount of content is estimated to be between a third and half of that required by analogue television (Burns 2004).

The following alternatives have been outlined for new uses of the freed spectrum (RSPG 2004):

1. Increasing the amount of content
2. Enhancing the content (e.g. multiple angles in sports events)
3. Higher quality content (HDTV)
4. Other electronic communication services (e.g. new frequencies for UMTS)

Determining how to distribute the freed spectrum will pose a problem for regulators, as they need to determine if prioritizing broadcasters as users of the spectrum is in public interest, or if they should be treated equally with other potential users. Burns (2004) suggests that, due to the convergence between broadcasting and communication, broadcasters should not be treated differently, and so the spectrum could be auctioned to the highest bidder. This is the approach taken in the US,

where the FCC has already reallocated the upper part of the television broadcast spectrum to other wireless services (Burns 2004). The alternative approaches to spectrum management are discussed in detail in the following section.

3. Spectrum Management Approaches

Spectrum policy decisions are related to the following three broad issues (Analysys 2004):

1. *Spectrum allocation*: What types of uses should be allowed?
2. *Spectrum assignment*: Who should be allowed to operate the frequencies?
3. *Centralized vs. decentralized decision-making*: Should decisions on allocation and assignment be made by the state or be devolved to users?

In a centralized approach, also referred to as *command-and-control*, both allocation and assignment decisions are made by the government. *Spectrum trading* would allow the transfer of spectrum usage rights between parties in a secondary market. *Service and technology neutrality*, or spectrum liberalization, on the other hand, would devolve decisions over spectrum allocation to users, allowing the market to determine how spectrum is used. (Analysys 2004)

In the following sub-sections, three different spectrum management approaches are briefly introduced. More detailed discussion can be found e.g. in a report by Analysys (2004).

3.1 Command-and-Control Approach

The command-and-control approach, also known as the centralized or institutional approach, is the traditional and currently dominant way to distribute spectrum usage rights. In this approach, government institutions (e.g. National Regulatory Authority NRA or Spectrum Management Authority SMA) decide both on spectrum allocation and assignment. The spectrum assignments typically specify in some detail the systems that can be used, and secondary spectrum trading is not allowed.

After a certain part of the radio spectrum has been allocated to a certain service and/or technology, the spectrum assignment decision can be made in many ways. The most important assignment mechanisms include *first-come-first-served*, *beauty contests*, and *auctions*.

First-come-first-served assignment mechanism is typically used for those services, where spectrum demand does not exceed supply. The government has set the license prices in advance, and grants the licenses in the order they receive applications. This mechanism is typically used for fixed radio links, and is used e.g. in granting the 3.5 GHz spectrum licenses for WiMAX systems in Finland.

Beauty contests, or comparative selections, are traditionally used to assign spectrum licenses in situations where demand exceeds supply. The governments select the licensees from among the candidates, and are not bound to grant the licenses only on the basis of their willingness to pay. Beauty contests are typically used e.g. when granting licenses for TV and radio broadcasting, but also for mobile systems in many European countries, including Finland.

The third alternative assignment mechanism, auctions, was used when granting the 3G licenses in e.g. U.K., Germany, and Italy in the early 2000's. In auctions, the spectrum is simply assigned to those companies who value it the most; other criteria are less important.

Even lottery has been used in the USA, but this approach gives no guarantee that the most efficient operator is chosen.

3.2 Market-based Approach

In the market-based approach, the governments are only responsible for the primary spectrum assignment using e.g. auctions or other assignment mechanisms. After the primary assignment, secondary spectrum trading allows the usage rights to be sold to others. The users can also be given some degree of freedom in selecting how to utilize the spectrum, although some technical rules are still necessary to protect neighbors (geographical and spectrum-wise) from interference. Generally, spectrum trading and service / technology neutrality issues can and should be treated separately.

The European Commission is currently planning to shift its spectrum policy from the traditional command-and-control approach towards a more market-based approach. In EU's view, the principles of technology and service neutrality should be applied to spectrum management, and users should be given more power in deciding how to use the spectrum. This freedom may still be limited by some technical considerations, such as avoiding interference. Regarding spectrum trading, the Commission proposes to introduce spectrum markets in the EU by 2010. (European Commission 2005)

3.3 Commons Approach

In the commons approach, the government allocates license-exempt spectrum for some service or technology. After an allocation has been made, anyone can utilize the spectrum without the need for a license. In order to avoid interference, transmission power levels are typically limited, and the spectrum can also be allocated for some specific technologies only. Examples of technologies utilizing unlicensed frequency bands include e.g. wireless LANs and Bluetooth operating in the 2.4 GHz frequency band.

Spectrum licensing is generally justified by avoiding harmful interference, but in the past few years unlicensed spectrum has proved to provide a fertile ground for innovations (demonstrated by e.g. the evolution of WLANs). In the EU, the use of license-exempt spectrum is considered to be further extended and harmonized between the countries. The European Commission's view is that in the regulatory framework, individual authorizations (i.e. licenses) should be the

exception rather than the rule (European Commission 2005).

Table 3 summarizes the differences between the different spectrum management approaches.

Table 3: Comparison of spectrum management approaches (adapted from Analysys 2004)

Approach	Spectrum allocation	Spectrum assignment
Command-and-control approach	Centralized, use of spectrum pre-defined	Centralized, trading not allowed
Market-based approach	Liberalized, license holders may choose how to utilize the spectrum	Primary assignment centralized, secondary trading allowed
Commons approach	Centralized, restrictions on technology and Tx power levels	Unlicensed spectrum, no assignments

In addition to the approaches discussed above, technology development may open up new possibilities for spectrum management in the future. The role of technologies such as ultra-wideband (UWB) and software-based radios is currently under discussion.

Each of the three spectrum management approaches has its strengths and weaknesses, and they will undoubtedly all be used to some extent in the near future. Accordingly, the interesting question is which parts of the spectrum should be opened for trading / liberalization, which should be unlicensed, and which should be managed by the traditional command-and-control approach. An EU-wide balanced approach is currently sought after, and the optimal "mix" of spectrum management approaches will depend on various criteria, such as protection of systems from harmful interference, quality of service, and fostering the internal market and innovation (European Commission 2005). In Commission's view, the terrestrial bands used for broadcasting, mobile services, and fixed services are best suited for spectrum trading (Reding 2006).

4. Impacts of Spectrum Policy on Competition and Innovation in Europe

The shift towards market-based spectrum management approaches is often argued to increase the innovativeness and competitiveness of the markets. In this section, we try to identify some of these mechanisms and cause-effect relationships. The analysis is limited to qualitative reasoning and e.g. correlations between the identified variables are not measured.

The great success of GSM-based mobile communication systems results largely from the harmonized spectrum allocations and technology development in Europe. In 3G, the spectrum was also harmonized, not only in Europe but more or less globally. The wide variation in spectrum allocation approaches between European countries and the enormous sums paid for the licenses in e.g. Germany and U.K. have, however, raised concerns about the suitability of the current spectrum policy to meet the demands of today's marketplace.

In this analysis, we focus only on the market-based spectrum management approach, and scope the commons approach and e.g. UWB out of the discussion. In order to construct a balanced view of the benefits and drawbacks of market-based approach, we have studied the responses given by different European organizations to the *"Public consultation on secondary trading of rights to use radio spectrum"* issued by the European Commission (2004). Positive and negative comments were identified and collected, and the most important of those linked together as shown in Figure 1.

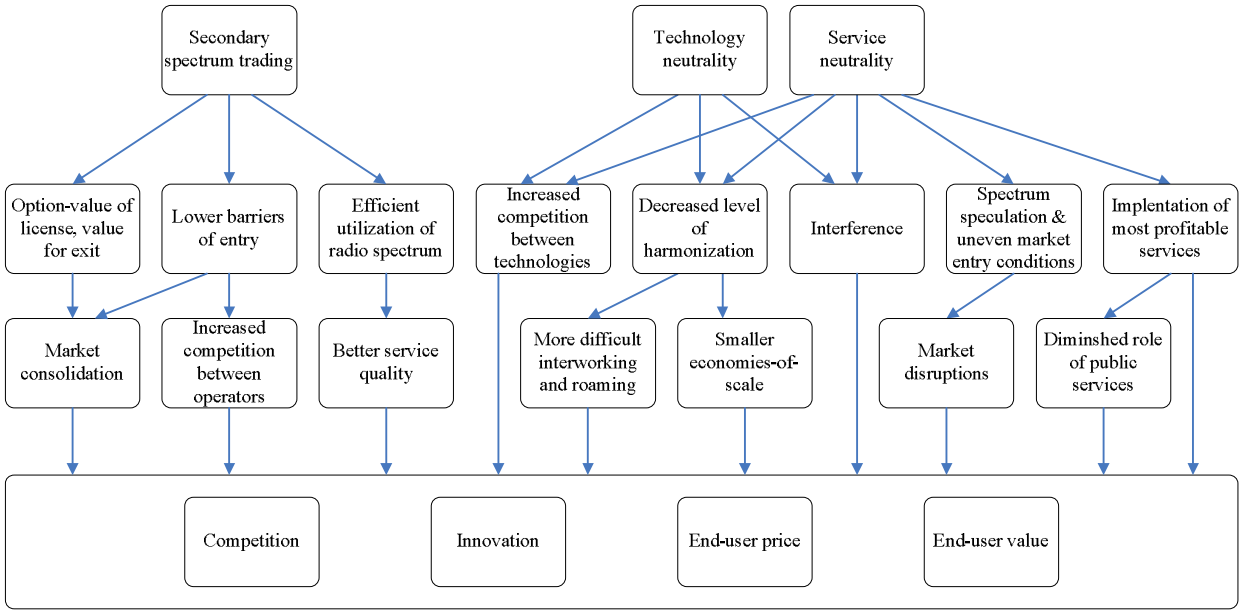

Figure 1: Possible impacts of spectrum policy choices on competition and innovation

Overall, the responses often shared many of the same concerns and perceived benefits. The respondents generally took either a positive or a negative view, and only a few covered concerns and benefits equally, indicating that the responses were motivated by the responding company's business interests. Of the respondents, one group stood out in particular; the satellite operators opposed any change to the current spectrum management policy. Often, spectrum trading without the right to change-of-use (service / technology neutrality) was considered to be a better choice than full spectrum liberalization, at least on the early stages of the development.

Proponents of secondary trading of radio spectrum mostly perceived the same benefits. Secondary trading would primarily increase competition by lowering barriers of entry into existing markets. Traditionally frequencies have been licensed in one-off events, making later entry into the market possible only by acquiring a company with a license. The easier exit from and entry to the markets was also seen as a driver for market consolidation. Another major benefit of secondary trading would be the increased efficiency of spectrum usage. Respondents envisioned operators selling surplus capacity to each other, or leasing capacity for other services in sparsely populated regions.

The effects of service neutrality and technology neutrality were other issues under consideration. Service neutrality was seen to maximise the economic value of spectrum, in that the services creating highest revenue would be implemented. This was also seen as a negative issue, as public services such as public broadcasters would likely be replaced by more profitable services. Also, device manufacturers and operators were seen as more unlikely to invest in development of new technologies if spectrum availability for them is uncertain. A possible negative effect that respondents named was *spectrum hoarding*, that is, the possibility of acquiring frequencies for speculative purposes or to lock-out competition.

Technology neutrality without service neutrality was seen in a more positive light. It would enable technology upgrade paths for operators using existing spectrum leading to faster time-to-market for new technologies, and one respondent mentioned South Korea as an encouraging example: South Korean operators migrated to 3G technologies in existing frequencies as early as 2000, and today 3G users make account for 75% of subscribers, contributing to a 12 – 18% increase in revenues due to add-on services (CDG 2004). Easier migration paths were also seen to lead to increased competition between technologies.

Negative aspects of both service and technology neutrality were smaller economies of scale for device manufacturers, and loss of international harmonisation, making interworking and roaming difficult if not impossible. These factors were also both seen to contribute to higher end user prices.

5. Summary and Discussion

Radio spectrum management and policy issues are complex, and it is difficult to claim one approach to be clearly better than another. Command-and-control, market-based, and unlicensed spectrum approach all have their strengths and weaknesses, and all are better suited for some services and technologies than others.

Transition from the traditional command-and-control approach towards a market-based approach will happen in stages, and care should be taken not to lose the benefits of the current system in the process. Furthermore, the choice between the regimes is not black-and-white; there are many different parameters that can be decided on independently. For different frequency bands, different combinations of decisions can be made in e.g. the following issues:

Table 4: Spectrum policy decision points

Issue	Possible outcomes
Primary assignment mechanism	First-come-first-served Beauty contest Auction
Secondary spectrum trading	Allowed / not
Technology neutrality	Yes / no
Service neutrality	Yes / no
Pricing	One-off Annual license fee

It is especially important to consider spectrum trading and change-of-use independently of each other. Our initial analysis indicates that the risks involved in the latter one are substantially higher. Therefore, secondary spectrum trading without the possibility to change the use of the spectrum service- or technology-wise could be a safe first step in developing the policy.

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ULTRA-WIDEBAND COMMUNICATIONS

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Abstract

Ultra-Wide Band (UWB) is a 30-year-old military wireless communications technology. Now it is being revitalized for wireless connecting device over short distances. The vital point UWB over Bluetooth is faster data speed, less expensive, and consumes less power. In this article, the overview of the technology is introduced, the comparison between Bluetooth and UWB is analyzed. The UWB standardization and vendor market strategy are represented. Finally, we consider the future development and possible end user applications.

Key Words

UWB, Bluetooth, wireless networks market, end user services, UWB standards

1. Introduction

Ultra-Wideband (UWB) is a technology anticipated to dominate the home networking market and eventually provide carriers with an inexpensive LAN alterative. It offers very high data rates, low power, less expensive cost. UWB provides 100 times the data speeds of Bluetooth solution, allowing transmission of large amounts of data i.e. video files between TVs or PCs as well as enabling high quality video applications for portable devices.

Bluetooth, which named after the 10th century Danish King Harold Bluetooth, is a hot topic among wireless developer. It was designed to allow low bandwidth wireless connections to become to use simply and integrate seamlessly within short range (10 meters). Bluetooth wireless technology is the simple choice for wireless, short-range, convenient communications between devices. It is a globally available standard that wirelessly connects mobile phones, portable computers, cars, stereo headsets, MP3 players, and more.

There are 50 companies making UWB chips worldwide, including Intel Corp. The estimated UWB chipset costs only $20. UWB is a very significant technology, it is a guaranteed win. But vendors have to agree on a standard. UWB faces serious regulatory hurdles as well. It is hard for UWB to move forward. The U.S. is the only country to approve spectrum for use by UWB radios. Ultimately, the success of UWB will depend on its low cost. With higher bandwidth, UWB will be adopted in enterprise wireless Personal Area Network (PAN).

The motivation of the study is:

- The pros and cons of UWB technology
- UWB vs. Bluetooth
- The current UWB standards
- The end user service cases and vendor strategy

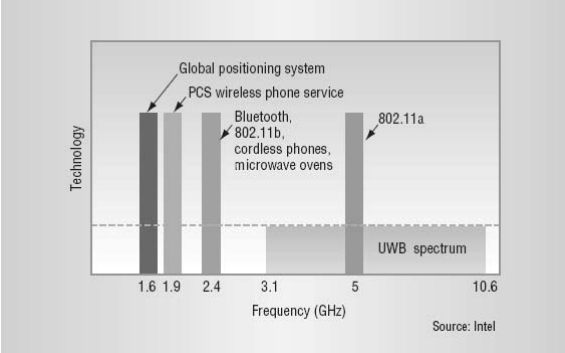
2. Technologies and Standards

2.1 Bluetooth

Bluetooth is a globally available standard that wirelessly connects mobile phones, portable computers, cars, stereo headsets, MP3 players, and more. It is an ad hoc technology that requires no fixed infrastructure and is simple to install and set up. Since the first release of the Bluetooth specification in 1999, over 4000 companies have become members in the Bluetooth Special Interest Group (SIG). Meanwhile, the number of Bluetooth products on the market is multiplying rapidly. A simple example of a Bluetooth application is updating the phone directory of your mobile phone. You would have to either manually enter the names and phone numbers of all your contacts or use a cable or IR link between your phone and your PC and start an application to synchronize the contact information. With Bluetooth, this could all happen automatically and without any user involvement as soon as the phone comes within range of the PC! You may expand it easily to your to-do list, memo, etc.

2.2 UWB

UWB is designed to replace cables with short-range, wireless connections, but it offers much higher bandwidth needed to support huge amounts of data streams at very low power levels. Examples include media players, monitors, cameras, and cell phones. Because UWB can communicate both relative distance and position, it can be used for tracking equipment, containers or other objects. UWB chipsets are built in complementary metal oxide semiconductor, so they rival inexpensive Bluetooth price when produced in volume. A recent technology demonstration showed a UWB device transmitted at a data rate of 110Mbit/sec. at a range of up to 10 meters.



(Source: Intel Corp.)

Figure 1 Wireless technology frequencies

As Figure 1 shows, unlike conventional radio systems, which operate within a relatively narrow bandwidth, ultra-wideband operates across a wide range of frequency spectrum by transmitting a series of extremely narrow (10 - 1000ps) and low power pulses.

The possible use of UWB technology in communications ranges from WLAN-like office or home networking and Internet access. By using 80% less power than 802.11a, UWB chipsets can work with smaller device such as PDAs and mobile phones without unduly burdening their batteries.

The primary advantages of UWB are high data rates, low cost, and low power. Because UWB is spectrum hopping, and only for a tiny fraction of a second, UWB causes less interference than narrowband radio designs, nearby neighbors will not interfere with other UWB networks. An additional UWB feature, precise ranging, or distance measurement is used for location identification, i.e. tracking persons. UWB uses very little power with long battery life. For the security issue, it is extremely hard to eavesdrop. It is like trying to track someone in a very busy street who continually changes different colors of clothes while running at extreme fast speed.

Despite the many benefits of UWB, it is currently embroiled in specification and standardization wrangling within the standard issuing bodies of the world and the USA, namely IEEE, ITU and the FCC (Federal Communications Commission). So even though Intel, Motorola and others are behind the technology, there are some who are hostile to its implementation. However this is a necessary step for technology to be grounded.

The drawback is such speeds only work over short distances. Communication speed is a function of bandwidth, power, and distance. The crossover point for UWB versus 802.11a wireless is 10 meters -- less than 10 meters, and UWB has higher bandwidth, but over 10 meters, 802.11a wins. Because of UWB's distance limitations, it will primarily be used for high-bandwidth local networks where the receiver can be plugged in, and not for cellular.

Another drawback is that UWB standards battle remains unresolved.

It is likely that UWB and Bluetooth could both be integrated into end-devices to serve different application spaces.

Table 1 compares the both technologies in spectrum, range, data rate, and user applications aspects.

Table 1: Bluetooth vs. UWB

	UWB	Bluetooth
Spectrum	3.1-10.6GHz	2.4GHz
Typical Range	10-30 meters	10 meters
Technology	OFDM or DS-UWB	Adaptive frequency-hopping spread spectrum
Max Data Rate	1Gbit/sec.	1Mbit/sec.
Typical Applications	Wireless synchronization and transmission of video or slide presentations between a laptop and a projector	Low-bandwidth wireless interconnect for synchronizing PDA and cell phone address book data with PCs
Availability	After 2007	Now

2.3 Current UWB Standards

2.3.1 IEEE 802.15.3

IEEE 802.15.3 is the IEEE standard for high data rate (20Mbit/s or greater) Wireless Personal Area Networks (WPAN) to provide Quality of Service (QoS) for real time distribution of multimedia content. IEEE 802.15.3 is accomplished by the IEEE P802.15.3 High Rate (HR) Task Group (TG3). The task group is charged with defining a universal standard of ultra wideband radios capable of high data rate over a distance of 10 meters using the 3.1GHz to 10.6GHz band (see Figure 1) for TVs, cell phones, PCs, and so forth. Besides a high data rate, the new standard will provide for low power, low cost solutions addressing the needs of portable consumer digital imaging and multimedia applications. In addition, ad hoc peer-to-peer networking, security issues are considered. When combined with the 802.15.3 PAN standard, UWB will provide a very compelling wireless multimedia network for the home.

The IEEE 802.15.3 standard enables wireless multimedia applications for portable consumer electronic devices within home coverage. The standard supports wireless connectivity for gaming, printers, cordless phones and other consumer devices. It can be

used to develop wireless multimedia applications including wireless surround sound speakers, portable video displays, digital video cameras. It addresses the need for mobility, quality of service (QoS) and fast connectivity for the broad range of consumer electronic devices.

2.3.2 WiMedia UWB

The WiMedia Alliance is a nonprofit open industry association that promotes and enables the standardization and multi-vendor interoperability of ultra-wideband worldwide. The new WiMedia Alliance represents a combination of WiMedia with the Multiband OFDM Alliance SIG (MBOA-SIG). Both are two leading organizations. They will publish and manage the industry UWB specifications for rapid adoption by for mobile, consumer electronics and PC applications. The MBOA-SIG Promoter companies include Alereon, HP, Intel, Kodak, Microsoft, Nokia, Philips, Samsung Electronics, Sony, etc. MBOA member companies are actively engaged with IEEE standards process.

The MOBA will announce its specifications for a physical layer ("PHY") and Media Access Control layer ("MAC") to enhance personal electronic devices mobility. The MBOA MAC and PHY specifications will serve as the common radio platform for industry standards. The MBOA MAC and PHY specifications, as published in Ecma-368, are intentionally designed to adapt to various requirements set by global regulatory bodies. The Multiband OFDM Alliance (MBOA) has devised its own media access control (MAC) layer, in effect rejecting the MAC mandated by the IEEE for the upcoming 802.15.3a standard. Enhanced support for mobility, mesh networking and management of piconets will be the key to the new MAC.

Other application-friendly features in MBOA include the reduced level of complexity per node, long battery life, support of multiple power management modes and higher spatial capacity.

3. End user applications

UWB has many other applications, for instance, medical imaging, automobile collision-avoidance systems, firefighters and police looking through walls, as well as finding and tracking assets and people. This is a technology which, in at least some applications, could be saving lives.

For MBOA UWB, anticipated early applications include the exchange of media content over high-data consumer electronics devices including MP3 players, personal media players (PMPs), set-top-boxes, digital cameras, hard-drives, printers/scanners, home-theater equipment, mobile phones, personal computers and video gaming platforms.

4. Marketplace and vendor strategies

The two sides in UWB standards battle are more polarized in wireless personal area networking market. It is sort of hard on both end users and vendors. It's obvious how end users suffer. They have to gamble on a standard proposal that might lose. For enterprise users, the risk may be unacceptable, leaving them, not with two (or three) options, but with none.

If one of the proposals wins, the companies that were involved in the losing proposal certainly take a serious hit. All their development time and investment is gone, and they have to design and build new chips. This could take two years or so. Even the winners have extra, competitive pressure from the desire to set a standard means they probably haven't been able to make as much money as they otherwise might off of a slow but steady start in a more cohesive marketplace. Marketing and promotion expenses are high for both groups.

One way of resolving a conflict that doesn't seem to be getting any better through the normal standards process is to let the parties fight it out in the marketplace. That is to say, let them ship products, and see which ones eventually win.

The risk of picking the wrong standard creates a real reason to adopt a "wait and see" attitude towards new standards. This is often the case where a fairly reserved approach is best -- committing to a losing standard doesn't necessarily help a lot.

The basic advice for standards battles is to stay clear. Wait until the dust settles a bit and you can tell what the standard is before adopting one.

5. Conclusion

Federal Communications Commission gave its approval to sell UWB wireless products in the U. S. Although the lack of an adopted standard will slow growth for a while, UWB will be used in 150 million devices by 2008.

It is reported that Bluetooth SIG consult with UWB developer to evaluate how the two technologies can improve data transfers between PCs, phones and consumer electronics equipments. UWB is the next generation of Bluetooth, it is a good idea to converge both technologies.

The challenge for UWB lies in the creation of a final unified standard. The current UWB standardization deadlock occurs. On the other hand. It may turn out that two standards find their own applications and in the end coexist nicely in different markets.

Since UWB is best used for short-distance and high-bandwidth applications, most of the development in UWB is targeted at HDTV and DLP video projection. UWB is not seen or designed as a replacement of

traditional Wi-Fi. It is more geared and designed more for the home. WiMax and MobileFi are seen as that replacement but that is another story.

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MOBILE BROADBAND WIRELESS ACCESS

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Abstract

Mobile broadband wireless access is needed to provide advanced telecommunications services effectively and affordably to consumers around the world. This paper evaluates the current commercial alternatives to satisfy that need: WiMAX variants, MBWA (IEEE 802.20), Flash-OFDM, and 3G technologies. Regulation aspects affect technology adoption and those are discussed along with the current market situation in all major market areas. Finland provides an interesting example and is handled separately and with more depth. Finally, vendor strategies and future developments are also evaluated to provide conclusions about which technology or technologies are most likely to gain market acceptance. Based on the material, both 3G (HSDPA) and mobile WiMAX (IEEE 802.16e) have widespread support and credible evolution and stand out as the main contenders for mobile broadband deployment within the immediate future.

Key Words

3G, HSDPA, LTE, WiMAX, Flash-OFDM, MBWA

1. Introduction

Emerging telecommunications applications such as multimedia streaming, music download, online gaming, and content browsing are popular examples of the digital revolution we have been facing, as the world gets connected. Fixed broadband access has already become an urban commodity in the developed countries, but so far there have been few means of delivering these bandwidth-consuming services effectively and affordably to the significant number of rural and mobile users. However, recent advances in e.g. signal processing, radio protocols, and mobile network infrastructure are now enabling the concept of mobile broadband for consumers around the world.

Mobile broadband is defined here as the potential to transfer low-latency user data with speeds exceeding 256 kbit/s while roaming the network with seamless handovers between adjacent cells. This paper presents the different mobile broadband technologies with commercial availability already or within a few years. Related regulation aspects are important factors affecting the regional markets. Industry insights and external analysis of the current market situation, significant vendors' strategies, and foreseen future developments are also used to draw the conclusions about the respective potential of these technologies.

2. Mobile Broadband Technologies

Currently there are a number of different technologies for broadband wireless access (BWA) for both fixed and mobile applications. Some of them are completely proprietary, based on vendor-specific solutions that are non-interoperable, while others are based on open standards developed by industry working groups. In the following subsections, we briefly describe the fundamental characteristics of the currently most significant wireless broadband technologies, focusing on key metrics such as operating frequencies, channel bandwidth, cell sizes, user data rates and latency, handover capabilities, and timeframe of availability.

2.1 WiMAX (IEEE 802.16-2004)

WiMAX is short for Worldwide Interoperability for Microwave Access and it is defined by the IEEE 802.16 Working Group. Although first intended for fixed applications, the initial WiMAX standards have evolved to form the basis for mobile WiMAX as well.

The current version of the fixed WiMAX standard is 802.16-2004, sometimes also referred to as 802.16d (IEEE 2004). It is essentially frequency independent, allowing also non-line-of-sight (NLoS) operation in the lower end of the frequency range (frequencies below 3 GHz, according to Richardson and Ryan (2006)) in addition to line-of-sight (LoS) operation. The radio access interface is based on Orthogonal Frequency Division Multiplexing (OFDM) with 256 subcarriers, although Orthogonal Frequency Multiple Access (OFDMA) with 2048 subcarriers and single carrier access modes are included in the 802.16-2004 standard as alternatives. OFDM allows good resistance to interference and multipath fading. Channel bandwidth ranges from 1.25 to 20 MHz, and either frequency division duplexing (FDD) or time division duplexing (TDD) may be used.

WiMAX cell size is dependent on the used frequency band, but coverage radiuses of 1 to 2 km for NLoS and 10 to 16 km for LoS are typical with standard base station equipment. With some optional enhancements, however, the figures are 4 to 9 km (NLoS) and 30 to 50 km (LoS) (Baines 2005). Actual data rates are also highly variable and depend on a number of factors. Although rates as high as 75 Mbit/s have been advertised, according to results of trials conducted by AT&T in late 2005, 2 Mbit/s over a range of roughly 5 to 10 km is closer to reality (Register 2005). For a comprehensive performance analysis, one may refer to,

e.g., Ball et al. (2005) and Song et al. (2005). Fixed WiMAX, as defined in 802.16-2004, does not support handovers or any other basic mobility mechanisms. As such, it lends itself only to fixed or, at most, nomadic applications.

2.2 Mobile WiMAX (IEEE 802.16e-2005)

Perhaps the biggest shortcoming of 802.16-2004 is the lack of support for mobility. IEEE addressed this issue by developing specifications for a separate version of the standard, the 802.16e, which was approved on December 7, 2005 (IEEE 2005). Also known as mobile WiMAX, the standard is seen to be in competition with 3G cellular technologies. Its radio access method is even more sophisticated than that of fixed WiMAX, utilizing scalable OFDMA and thus achieving an even better link budget. The tradeoff is increased complexity in physical layer processing. Fast handover signaling is supported, e.g., to allow users in moving vehicles to seamlessly switch between base stations. (Baines 2005)

Mobile WiMAX operates in the 2 to 6 GHz range that mainly consists of licensed bands. Mobile applications are likely to operate in frequencies below 3 GHz, while even some fixed applications are expected to use 802.16e due to its better characteristics. However, it should be noted that there is no backward compatibility with fixed WiMAX. Cell radiuses are expected to be typically 2 to 5 km, and user data rates up to 30 Mbit/s are achievable in theory with full 10 MHz channels. The first certified 802.16e products are expected to be available by late 2006, though wide scale commercial deployments are expected not earlier than 2008.

On a further note, South Korea has its own variant of mobile WiMAX called WiBro which is standardized by TTA. It uses 10 MHz channels in the 2.3 GHz band in Korea, and aims for interoperability with official 802.16e equipment. According to a recent performance analysis, WiBro performs favorably in comparison with 3G High-Speed Downlink Packet Access (HSDPA) in multipath fading channels (Shin et al. 2005).

2.3 MBWA (IEEE 802.20)

The IEEE 802.20 (or Mobile Broadband Wireless Access) Working Group was established on December 11, 2002 with the aim to develop a specification for an efficient packet based air interface that is optimized for the transport of IP based services. The goal is to enable worldwide deployment of affordable, always-on, and interoperable BWA networks for both business and residential end user markets. The group will specify the lower layers of the air interface, operating in licensed bands below 3.5 GHz and enabling peak user data rates exceeding 1 Mbit/s at speeds of up to 250 km/h. (IEEE 2006a)

The goals of 802.20 and 802.16e are similar. However, 802.16e is much more mature, whereas even the standardization process of 802.20 is far from complete. A draft version of the specification was, however, approved on January 18, 2006 (IEEE 2006b).

2.4 Flash-OFDM

Flash-OFDM, short for Fast Low-latency Access with Seamless Handoff OFDM, is a proprietary wireless broadband technology originally developed by Flarion Technologies which was recently acquired by Qualcomm, a major developer and patent holder of Code Division Multiple Access (CDMA) and other advanced wireless technologies.

As the name implies, Flash-OFDM's radio access method utilizes OFDM in relatively narrow 1.25 MHz FDD channels. Frequency hopping is employed in the subcarriers, which provides frequency diversity. Operation is supported in several licensed frequency bands, such as 450 MHz, 700 MHz, 800 MHz, 1.9 GHz, and 2.1 GHz. The network is all-IP based, and inherently supports applications such as VoIP due to its low latency and enhanced QoS support. Flash-OFDM is claimed to reach user data rates of 1 to 1.5 Mbit/s in downlink and around 300 to 500 kbit/s in uplink, with a typical latency of 50 ms. (Rysavy 2005, Flarion 2006)

Compared to mobile WiMAX, Flash-OFDM has a time-to-market advantage in that its equipment is readily available on the market, but a major disadvantage in having only limited vendor support and not being an open technology. Interestingly, Flash-OFDM is also a candidate for the IEEE 802.20 standardization effort. (Rysavy 2005)

2.5 3G

3G cellular systems, most notably UMTS, are currently the most widely deployed mobile broadband technology with a huge established presence in terms of operators, customer base, brand, deployed base station sites, and backhaul capacity. Standardized by 3GPP in its Release 5, HSDPA is a tremendous performance upgrade for UMTS packet data, enabling peak data rates up to 14.4 Mbit/s, although the initial limit is 1.8 Mbit/s. Latency is also reduced, and spectral efficiency is improved as well. These improvements are achieved through improved modulation and coding, and implementing fast scheduling and retransmissions at base station level.

The radio access method of UMTS is known as Wideband CDMA (WCDMA). Although most WCDMA deployments are based on FDD where different radio bands are used to separate downlink and uplink transmission, 3GPP specifications also include a TDD version of UMTS where both transmit and receive functions alternate in time on the same radio channel. This can be beneficial for the many asymmetric data applications that consume more bandwidth in the downlink than in the uplink. A TDD radio interface can dynamically adjust the downlink to uplink ratio accordingly, and thus can balance both forward link and reverse link capacity. Spectral allocation is also more straightforward, as TDD requires only one band instead

of two bands and a further guard band in FDD. UMTS TDD is also known as Time Division - Code Division Multiple Access (TD-CDMA) and has been commercialized by the vendor IP Wireless. (Rysavy 2005, Esmailzadeh et al. 2003)

2.6 Comparison of Key Metrics

To summarize, the key metrics of the different technologies described above are listed in Table 1. It should be noted that especially the cell radius and round-trip time (RTT) figures are only approximations in typical conditions and as such are not necessarily accurate. Furthermore, for FDD based technologies, the channel bandwidth is given for one link direction only.

Table 1: Mobile broadband metrics

Technology	Channel band-width	Cell radius	Data rates (DL)	RTT
Fixed WiMAX	1.25–20 MHz (FDD)	1–9 km, 10–50 km	< 75 Mbit/s	< 50 ms
Mobile WiMAX	1.25–10 MHz (FDD)	2–5 km (typical)	< 30 Mbit/s	< 50 ms
802.20	1.25–??? MHz	MAN scale	> 1 Mbit/s	N/A
Flash-OFDM	1.25 MHz (FDD)	5–20 km (typical)	1–1.5 Mbit/s	50 ms
WCDMA/ HSDPA	5 MHz (FDD)	< 0.1 km, < 1 km, < 20 km	1.8–14.4 Mbit/s	< 100 ms
TD-CDMA	5 or 10 MHz (TDD)	2.5–30 km (typical)	1.5–3 Mbit/s	< 50 ms

3. Regulation Aspects

Almost all current BWA technologies are designed to operate in licensed frequency bands, although the available bands for them may differ across countries and regions. This is especially true for 3G, Flash-OFDM, and 802.20.

UMTS, as part of the global International Mobile Communications-2000 (IMT-2000) standard for 3G wireless communications, had its core frequency bands defined in the World Administrative Radio Conference (WARC-92) already in 1992. The core bands, 1885-2025 MHz and 2110-2200 MHz, are further divided into FDD and TDD bands, the former being 1920-1980 MHz and 2110-2170 MHz (paired, 2x 60 MHz), and the latter being 1900-1920 MHz and 2010-2025 MHz (unpaired) (CEPT 2004). These bands have been allocated for IMT-2000/UMTS practically everywhere in Europe and also in Japan, as Europe and Japan have agreed to common frequency bands for UMTS applications. Australia has similar allocations as well. There are, however, minor differences in actual available channel bandwidth between countries, but nevertheless, the frequency allocations are quite homogeneous, which is a clear advantage for UMTS.

The situation is different in North America (and parts of Central and South America) where there are multiple IMT-2000 based 3G technologies in use, namely cdma2000 and UMTS. In the United States, UMTS currently operates in the 850 MHz and 1900 MHz bands that are shared by existing 2G deployments (mainly GSM and legacy D-AMPS), due to the fact that no bands have been specifically allocated for UMTS. The core bands used for UMTS in Europe are either used for cdma2000 or other applications. More specific details on current and planned IMT-2000 frequency band allocations worldwide can be found in, e.g., ITU-R (2006).

Mobile BWA technologies other than those based on IMT-2000 have a disadvantage in that they typically need to compete for spectrum in frequency bands that may be crowded with other applications (legacy wireless communication systems, analog TV broadcasts, etc.) that vary from country to country. As a result, it may be difficult to obtain large geographical coverage using the same frequency bands (and equipment) due to the scarcity of licensed spectrum. Moreover, national communications regulatory authorities have great influence over which technologies gain entry to national markets. In Finland, for example, the 450 MHz band previously occupied by the legacy Nordic Mobile Telephone (NMT) service was recently designated to Flash-OFDM although the cdma2000-based technology CDMA 450 was also considered (see Section 4.1 for details). In the near future, when analog TV broadcasts are gradually shut down in favor of digital broadcasts and any remaining legacy wireless communication systems (which may include even 2G systems in some regions) are phased out, there may be more bandwidth available below 2 GHz that is usable for mobile BWA technologies.

For WiMAX, the situation is somewhat better, as operation is possible in a wide range of frequencies including also unlicensed bands such as 5.8 GHz and 5.3 GHz. However, most current deployments seem to use licensed bands such as 3.5 GHz and 5 GHz in Europe. In the United States, the 3.5 GHz band is not available for this purpose, but the 2.5 GHz band may be used instead. Figure 1 shows the global distribution of licensed WiMAX frequency bands, excluding some licensed bands below 2 GHz (e.g., 700 MHz, see Richardson and Ryan (2006)) for which there are planned WiMAX deployments.

Wi-Fi-like mass deployment in unlicensed bands seems attractive also for WiMAX, but it is much more complex due to the higher transmission power levels and the fragmented radio spectrum. The performance and reliability of unlicensed WiMAX is likely to be considerably poorer than that of licensed operation, as significant levels of interference are present in the unlicensed bands. Licensed bands allow operators to

manage frequency planning, and as this cannot be done for unlicensed bands, different techniques are needed. Although Carrier-Sense Multiple Access (CSMA) is sufficient for Wi-Fi, a considerably more stringent radio access control mechanism is necessary for WiMAX (Baines 2005). This, in turn, leads to increased complexity. Taking into account the effects of terminal mobility, fast fading channels, and the long ranges in which WiMAX is designed to operate, this complexity is even more evident. Although equipment for unlicensed WiMAX operation is already available on the market, little information is available on any actual deployments.

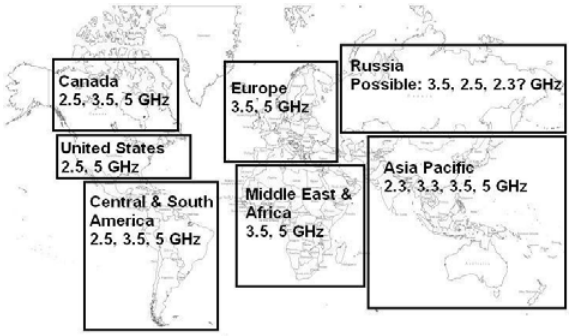

Figure 1: WiMAX frequency bands (Baines 2005)

The selection of operating frequency affects not only cell radius but consequently also cost of coverage. This is why lower frequency bands such as 450 MHz and 700 MHz are attractive for nationwide BWA deployments. The relationship between frequency, radius, and weighted average cost per km^2 is depicted in Figure 2. However, one should note that the cost of coverage is not always the dominant cost factor for a network operator, but cost of capacity may be more important. Providing high end-user data rates simultaneously for a large number of subscribers in densely populated areas necessitates a small cell size regardless of operating frequency.

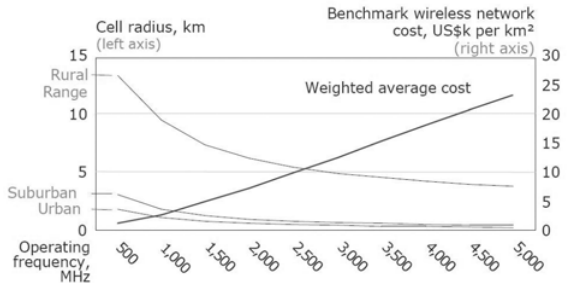

Figure 2: Frequency vs. radius vs. cost (Lee 2005)

4. Current Market Situation

Although most BWA technologies are still in a state of infancy, with at best first generation products on the market, there are already a number of fixed and even some mobile BWA networks operational around the world. The fixed deployments are mostly based on pre-certified or certified WiMAX (802.16-2004), whereas the mobile deployments use either HSDPA or proprietary technologies.

4.1 Finland

Finland's first WiMAX networks were deployed in the rural areas of North Ostrobothnia and Pirkanmaa during the first half of 2005. Similar deployments followed later in South Savo. Their operators are mainly local players. Finland's first true city WiMAX network was deployed in Turku in October 2005. The networks operate in the 3.5 GHz band which is currently the only available licensed band for WiMAX use in Finland.

3G FDD licenses in Finland have been divided between the main GSM network operators: TeliaSonera, Elisa, and DNA. Geographically these networks are still quite small, but major cities already have coverage. As the first operator globally, Elisa has upgraded its whole 3G network into HSDPA and opened it for commercial use already in April 2006. At least TeliaSonera is expected to follow that move during the near future. One 3G TDD license has also been awarded to a small company called SkyWeb, which is planning to build regional networks around Finland as needed.

Another interesting development is the decision to grant an operating license for a Flash-OFDM based mobile broadband network in the 450 MHz band to Digita Oy on June 22, 2005 (LVM 2005). Digita has already conducted trials in the Helsinki metropolitan area in late 2005. In its first phase, the network is expected to cover 204 cities and municipalities by September 2006, including the coastal areas and parts of Eastern and Northern Finland. Digita has intentions to act purely as a network operator, leasing network capacity to potentially multiple service operators, utilizing an open network model where the risks are shared.

4.2 Europe, Middle East, and Africa

In the United Kingdom, the local company Telabria launched the country's first WiMAX network in the Kent area in September 2005. The start-up Urban Wimax launched the country's first certified WiMAX network in Westminster in March 2006. In Sweden, the first pre-WiMAX network in the Nordic countries was deployed already in December 2004.

Most European countries have distributed their 3G licenses, and there are now numerous 3G networks in active use. The major operator groups like Vodafone and Orange are running commercial HSDPA trials, but the aspiration towards HSDPA is at least equally great with the greenfield 3G operators like '3' and mass deployments are expected within this year. New growth areas for 3G include individual African countries and the Middle East, where e.g. Kuwait's Wataniya Telecom is actually already running HSDPA.

In South Africa, Wireless Business Systems provides a mobile broadband network based on ArrayComm's

proprietary iBurst technology, a.k.a. High Capacity Spatial Division Multiple Access (ArrayComm 2004). The current coverage includes five major cities.

4.3 Americas

In the United States, there are operational WiMAX networks in major cities such as Boston, Chicago, Los Angeles, New York, San Francisco, provided by Towerstream, and in Seattle, provided by Sprint Nextel and Speakeasy. Several other trials and deployments are also underway. In Canada, a national pre-WiMAX network covering over 100 urban and rural areas was announced in March 2006. In Colombia, the local company Telecom launched WiMAX in the city of Bucaramanga in January 2006, with other cities such as Bogotá, Medellín, and Cali to follow during the year.

Latin America is still building up their basic GSM networks, so the interest for HSDPA has been mostly dormant for now. However, individual countries with high subscriber penetration have already started their evolution towards 3G. North America is different to the rest of the world in the sense that GSM/UMTS serves only a minority of the cellular subscribers. As the rivalry between technologies is fierce, Cingular Wireless is using HSDPA to attract customers. T-Mobile USA is expected to follow Cingular and launch a 3G network some time next year.

4.4 Asia Pacific

In South Korea, WiBro roll-outs in the 2.3 GHz band are scheduled to start in April 2006. In the first stage, only simple mobility is supported. Taiwan has similar plans, with trials expected in the second half of 2006.

Apart from Korea, Asia Pacific is heavily involved with 3G. Japanese operators had the first commercial UMTS networks and are accelerating them now with HSDPA. New entrants with e.g. UMTS TDD are also expected. 3G deployment is on-going in Australia and the Philippines, while China is expected to grant licenses for UMTS within the near future.

In Australia there are currently also two large proprietary mobile broadband deployments. Personal Broadband Australia has nearly nationwide coverage with iBurst and Unwired Australia uses Navini Networks' proprietary Ripwave solution in its sites in Sydney and Melbourne. A major difference between the two is that iBurst offers true vehicular mobility, whereas Ripwave is limited to fixed or nomadic use. Both currently support speeds up to 1 Mbit/s.

4.5 Current and Future Prospects

3G and fixed WiMAX are off to a good start in the developed markets, but many operators are faced with the difficult decision whether to wait for mobile WiMAX certified products. The role of proprietary mobile broadband technologies such as Flash-OFDM also remains to be seen, as the existing market niches for them are fragmented and immature. In spite of the technological uncertainty, studies forecast exponential 3G and other BWA subscriber growth for the next few years. For WiMAX, one such estimate is depicted in Figure 3. The numbers can be compared with e.g. Strategy Analytics' estimate that the total number of 3G subscribers doubles this year to 100 million (Strategy Analytics 2006). Currently something like 5% of 3G subscribers are laptop data card users, so HSDPA early adopter market could also be counted in the millions.

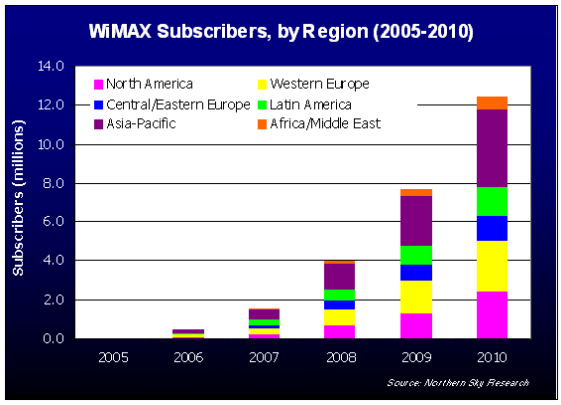

Figure 3: WiMAX subscribers by region (Northern Sky Research 2005)

5. Vendor Strategies

The major telecommunications vendors providing mobile broadband can be roughly divided into three categories: chipset, infrastructure, and handset suppliers. Chipset providers operate in a horizontal industry and are easy to distinguish: Intel, Qualcomm, and Texas Instruments are the largest and most important silicon vendors for telecom equipment manufacturers.

It is harder to draw a line between infrastructure and handset vendors, as some companies like Nokia have significant business in both areas leading to true end-to-end capability, and some vendors like Samsung are striving hard to eventually build a similar situation. By looking at where the majority of their sales come from, one can, however, categorize Nokia, Motorola, and Samsung as being nowadays mostly handset vendors.

Ericsson and Cisco are clearly the two iconic vendors for network equipment. After selling its handset business to BenQ, Siemens clearly also belongs to this category. The recently announced merger between Alcatel and Lucent will create a formidable player to challenge these three and Nokia. Nortel keeps on suffering from its bookkeeping discrepancies, but is still a notable vendor in some regions. As for Asian companies, NEC is involved with Siemens in 3G network development and Fujitsu has been working with Alcatel in another 3G joint venture. Chinese Huawei and ZTE are trying hard to establish their position and capability to serve developed markets outside of their natural home domain.

Ever since Qualcomm announced to buy the Lucent spin-off company Flarion in November 2005, the future of Flash-OFDM technology has been somewhat uncertain. Amidst other takeover rumors, Siemens is partnering and playing around with all technologies and had even some activities with Flarion (Siemens 2005), but those may have been hurt by the technology acquisition. As Qualcomm is a renowned IPR powerhouse and major chipset vendor for all 3G technologies, Flash-OFDM is now mostly seen as a proprietary step towards IEEE 802.20. Hence the main battlefront of mobile broadband has formed between 3G and IEEE 802.16e. Figure 4 is a rough illustration of where different vendors are strategically aiming, not necessarily where they are today.

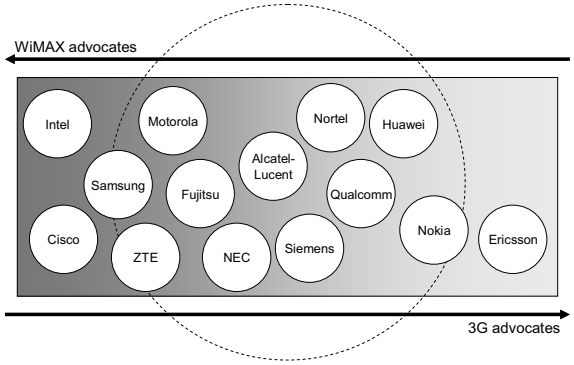

Figure 4: Strategic inclination of telecom vendors

However, despite the strategic inclinations, pretty much all vendors seem to be playing both sides of the game. For example, even Intel, one of the strongest proponents of WiMAX technology with related partnerships to several other vendors, believes that both 3G and WiMAX will coexist and work in tandem to meet the global needs (Intel 2004). This is naturally due to the fact that Intel has also major business in current 2G and 3G technologies and does not wish to disrupt them too much. As laptop users are undeniably the first potential mass-market adopters of mobile broadband, Intel is in any case in a key position to integrate the required radio technologies to its various chipsets.

Samsung is another interesting player. It has a good market position with basic 3G and first HSDPA handsets and continues strongly on that path, but at the same time, it wants to expand its position in the value chain and sees WiMAX as the opportunity to do that. Samsung has extensive pre-WiMAX experience due to the early WiBro deployment in South Korea (Cherry 2005). Nortel also has some experience from WiBro, as it has worked in cooperation with LG in the Korean market. Curiously, despite or exactly because of that experience, Nortel has until recently been more focused on 3G long-term development (Nortel 2006).

Motorola is in a similar position as Samsung. It has good business with 3G handsets, but has not managed to gain foothold as a 3G infrastructure vendor. Motorola also sees WiMAX as the opportunity to get back in the end-to-end game and challenge the market leader Nokia. Cisco is another natural supporter of WiMAX, as it is a major player in Wi-Fi and has not established 3G business. However, Cisco's strategy is to partnership with other vendors and to provide the broadband IP technology needed in base stations (Cisco 2004).

Although Huawei does not yet have a solid HSDPA commercial offering, it has gained some basic 3G network deals in the new growth markets. Its local rival ZTE has not been as successful, so it appears to be aiming its resources more towards WiMAX. ZTE is even one of the board members in the industry body WiMAX Forum along with Intel, Motorola, Fujitsu, and Samsung (WiMAX Forum). It remains to be seen how the merger eventually affects Alcatel and Lucent, but at least the former has previously also been a clear WiMAX advocate (Alcatel 2005).

Being the market leader in 2G/3G network infrastructure, Ericsson is obviously pushing for HSDPA. It sees WiMAX more as a semi-fixed access technology, but is keeping an eye on the developments anyway. Nokia, the leading mobile handset vendor and #2 in networks is somewhat more interested in WiMAX, but also promotes it mainly as an alternative to operators without a 3G license (Nokia 2005). Some advanced Nokia handsets already support both Wi-Fi and 3G, and adding WiMAX should be a logical step. Figure 5 presents Nokia's vision of radio technologies and their evolution. It is also worth to note that Texas Instruments is a key supplier to Nokia and closely supports their visions with the needed silicon.

HSDPA data cards with Qualcomm chipsets are already commercially available from several OEMs, and handsets are expected in the second half of 2006 from all the major 3G handset vendors including Nokia, Samsung, and Motorola. By then Samsung will also have its WiBro handset on the Korean market, and the first mobile WiMAX-capable data cards using Intel chipsets should become available as well. Unlike 3G, it is probable that the Taiwanese OEM vendors will play a significant role with early WiMAX equipment. Nokia, Motorola et al. are, however, prepared to follow them soon if or when the volumes take up.

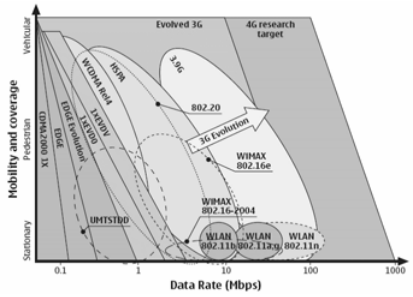

Figure 5: Nokia's vision of radio access (Nokia 2005)

6. Future Development

It is becoming clear that the current year 2006 will mark the true beginning of widespread deployment for mobile broadband. 3G/HSDPA and mobile WiMAX are seen as the main contenders, although they can also be used as complementary technologies in a number of markets. In the meanwhile, user experience continues to improve with upcoming enhancements on several levels.

High-Speed Uplink Packet Access (HSUPA) is included in 3GPP Release 6. The combination of HSDPA and HSUPA is often called simply HSPA. It will deliver uplink data rates of up to 5.76 Mbit/s and further decrease the network RTT to a level of 50 ms. HSUPA trials are expected to begin gradually, and the technology is bound to hit the market in 2007.

More fundamental 3G developments proceed under the umbrella term of UMTS Long Term Evolution (LTE). Key elements are currently being standardized for 3GPP Release 8, and LTE aims for peak data rates of 200 Mbit/s for downlink and 100 Mbit/s for uplink. Such improvements are sought with the help of new radio technologies as well as architectural evolution, cf. Nortel's HSOPA concept (Nortel 2006).

While the current 3G network architecture is well suited to handle voice applications and mobility, it is quite heavy for most data services. WiMAX-like flat network architecture would be more cost effective in many cases, and LTE is studying such alternatives as well. There are already a number of 3G pre-LTE solutions including Nokia's Internet-HSPA (I-HSPA), Lucent's Base Station Router (BSR), and Motorola's AXPT.

As a common step for WiMAX, 3GPP Release 7, and other radio technologies, Multiple Input Multiple Output (MIMO) antennae systems are expected to materialize within a couple of years. They provide increased capacity by using multi-stream transmissions, but require a lot of processing power to handle that. Increased power consumption will probably also delay MIMO's initial adoption to mobile environments.

The TDD world is evolving as well. As licensed frequencies are becoming a scarce resource, TDD's single band operation may prove to be just what is needed. China is perhaps the single biggest driver behind TDD, as it tries to cumulate knowledge and relevant IPR for business and political reasons. E.g., the TDD Special Work Group has contributed an interesting vision of the future (Ping et al. 2005).

Finally, if different access technologies are used to complement each other, inter-system handovers need to be solved in an elegant way. One possible solution for data is to use Mobile IP and Home Agents either within the networks or directly in terminals. The related signaling could be based on Session Initiation Protocol (SIP) with an IP Multimedia Subsystem (IMS) machinery to take care of network core functions.

7. Conclusions

Mobile broadband wireless access is strongly entering the consumer markets (Burton 2005). There are several alternative technologies for it, the most notable of which are 3G HSDPA and mobile WiMAX. Both standards enjoy economies of scale through widespread support among leading vendors and operators, while proprietary solutions such as Flash-OFDM are more likely to end up as niche solutions and suffer from scarcity of frequencies.

While licensed frequency bands are generally sought for BWA deployment, regulators have much power to influence over the technology selection. Finland will provide an interesting example with all the major technologies represented: 3G/HSDPA, WiMAX, Flash-OFDM, and even 3G TDD. Globally thinking, HSDPA will build upon existing 3G/GSM networks with vast subscriber bases, while WiMAX seems more popular with greenfield entrants and operators that have pure Wi-Fi or fixed background.

The general conclusions and more detailed analysis must be considered at least from three points of view: end users, operators, and equipment vendors. Vendors can be strategically divided between 3G and WiMAX, but most of them seem to play both sides of the game until or unless a clear victor converges. Developing or even supporting two types of equipment may be expensive, but betting on the wrong horse would still be more expensive, considering what the incumbent vendors have to lose. The end of this year should witness terminals for both technologies, and perhaps even multimode devices.

Operators have a vested financial interest to keep the number of their access networks as small as possible. It is not likely that a typical 3G operator would build a complementary mobile WiMAX network or vice versa. However, varying frequency availability and other market differences may become important multiradio factors for the regional and global operator groups aiming to provide full roaming services. Inter-system handovers may also come to question, e.g., if or when greenfield operators purchase coverage outside of their own hotspots by acting as a virtual operator in some incumbent's network.

Finally, the vision of complementary technologies is quite user-centric: consumers need not know what network they are using as long as their services work. Such functionality may require e.g. some protocol changes as discussed, but those should be technically feasible, and both vendors and operators are now putting focus on them. Increased competition and lower switching costs benefit consumers by fueling both performance development and continued price erosion of mobile technologies. There are already several upcoming enhancements which promise to further improve the user experience, to provide the services more cost efficiently, and make the technology battle even more interesting.

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UNLICENSED MOBILE ACCESS

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Abstract

The idea of using unlicensed radio in mobile handsets for interconnecting with the core mobile network is interesting both technically and economically. The installed base of wireless access points has increased through the emergence of reasonable priced and easy to use WLAN equipment to accessing Internet with broadband connections. The use of unlicensed radio spectrums is expected to give economical benefits both for the end users and to operators. Based on a literature study, this paper depicts the current situation of UMA technology and its influence for businesses of operators and telecomm vendors as well as the benefits for the users

Key Words
UMA, GSM, 802.11, Fixed-Mobile Convergence, IMS

1. Introduction

Many users, at least outside of Finland, still have a fixed line telephone at home and in the office in addition to a mobile phone. Most of them would prefer just one mobile device, which could provide all needed communications services without needing to worry about what network is available. The unification of fixed and mobile devices as well as their services is often called with term fixed-mobile convergence (FMC). In this paper we look how UMA technology is enabling this kind of evolution. Also we briefly look the status of the other related standards.

FMC is an important issue for many other stakeholders than end users. We discuss the influences of UMA for different players like operators and vendors. Descriptions of enabled end user services and a successful pilot are given. In the end of the paper we conclude how we see the situation of UMA today.

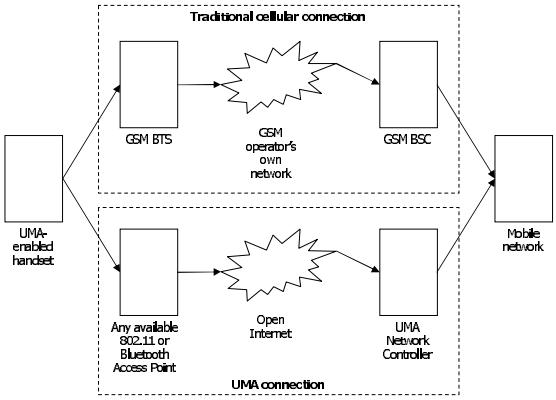
2. UMA Technology Overview

Unlicensed Mobile Access (UMA) is a technology that connects regular unlicensed wireless networks to GSM networks. The wireless networks are currently limited to Bluetooth and 802.11, but soon others will follow. UMA defines a UMA Network Controller, UNC, which connects to the mobile network using standard A/Gb connections, replacing GSM's Base Station Controller (BSC). All GSM services are tunneled through the IP pipe, including GPRS. Of course, data transfer speeds are quite a lot faster than with cellular access (UMA Technology).

Calls and data connections feature seamless handover between cellular and UMA, as well as roaming back to cellular if UMA isn't available. UMA enabled phones can use any standard 802.11 access point for connection, though naturally the AP must provide open Internet access for the user. The network features multiple UNCs, one of which is a default one. The default UNC chooses another UNC for the mobile terminal if needed based on the network topology.
The mobile terminal connects to the UNC via unlicensed wireless networks and fixed line, using point-to-point IPSec ESP encryption. The UNC contains a security gateway (SGW), which takes care of the IPSec tunnel and IKEv2 authentication (Mobile Pipeline). The subscribers are identified by SIM credentials, and the SGW is connected to GSM's AAA service for subscriber authentication.

Calls are transferred through IP bearers (RTP and UDP), using the same data flow as with VoIP networks. GPRS connections are carried by TCP using a lightweight UMA-RLC protocol, which is suitable for always-on broadband connections (Mobile Pipeline).
Right now, there are no phones implementing UMTS and UMA at the same time – only handoff between GSM and UMA exists. At the moment, the UNC does not support all of the UMTS services, so development still goes on (InCode 2006).

Figure 1: UMA compared to standard GSM



3. Status of Related Standards

The idea of developing open standards are seen as an important enabler for the diffusion of new telecommunication technologies since consensus over specifications will ensure interoperability between handsets and networks from multiple vendors. There can be seen three related standard initiatives that Third Generation Partnership Project (3GPP) is working on in the area of FMC. The estimated time of commercial launches as well as the technical maturity of these initiatives differ (InCode 2006). The status of each related standard is briefly discussed including some comparison in the order of estimated commercial launch using WLAN as access technology.

3.1 UMA Standards

UMA forum was established in January 2004 by leading telecom vendors and operators. The goal for their work was to develop and publish open specifications that would support GSM services over unlicensed radio. The initial UMA specifications were published in September 2004 after nine months work. About at the same time UMA was included as a Third Generation Partnership Project (3GPP) work item under the name "Generic Access to A and Gb interface" (GAAG). On April 2005 these specifications were approved for 3GPP Release 6. The latest version (6.5.0) of this standard (TS 43.318) was released January 2006.

UMA forum has discontinued operating as an independent group but the participants are continuing the UMA technology work within 3GPP under the name Generic Access Network (GAN). This work will be coordinated with the standardization and development work of GSM and UMTS (UMA Technology).

3.2 WLAN Interworking Standards

The second potential standard initiative that may be used in FMC is WLAN Interworking (I-WLAN). The goal of this initiative is integrating WLAN with the GSM infrastructure. The initiative defines a stepwise approach trough six scenarios. Basic scenario includes reusage of SIM authentication and billing infrastructure for public WLAN hotspots. The advanced scenario includes seamless mobility between radio bearers and access to the GSM CS domain for voice similar to UMA. Currently the first three scenarios are fully standardized. As current focus of I-WLAN is on user authentication in public WLAN hotspots, there are no overlaps with UMA. This user-transparent authentication via the SIM card can be regarded as a complement to UMA for public hotspot usage, but many existing WLAN hotspots have been integrated to GSM authentication and billing system with special connection-manager software already, thus reducing the incentives to change to I-WLAN. The deployment of UMA architecture needs less new nodes and integration work in the network than I-WLAN, which is an advantage for UMA (InCode 2006).

3.3 IMS Standards

IP Multimedia Subsystem (IMS) is a 3GPP standard that specifies a generic architecture with extensive support for multimedia services and Voice over IP (VoIP). The idea of IMS is also to support many access technologies including unlicensed spectrums using Session Initiation Protocol (SIP) for the network signaling. This access mechanism would provide an alternative to UMA technology as soon as IMS will start to support seamless handover of voice calls between mobile networks and WLAN. This improvement is called Voice Call Continuity (VCC) and it is currently being standardized and scheduled for delivery by mid-2006 enabling commercial services to be launched probably only after two years from that (InCode 2005).

Since IMS could provide usable WLAN access with VCC for FMC solutions to operators only in 2008 at earliest, UMA is seen as only realistic standardized choice in short to medium term, especially since UMA solution works with or without IMS. The only concern for using UMA with IMS is the realization of Quality of Service (QoS) in the access network. UMA itself supports IP QoS standards (Diffserv), but there is no guarantee that the broadband access network supports QoS if the operator does not control it. The need for QoS and its impact for IMS service performance is anyway decreasing as transmission speeds are increasing in WLAN and broadband access networks (InCode 2006).

4. End User Services

UMA technology can benefit both consumers and enterprises with positive user experience and cost savings. Savings may come though owning and using only a single phone and lower service prices. Mobile network access though WLAN and broadband connection is providing bigger bandwidth than GPRS, EDGE or UMTS. Especially this will greatly complement to GSM network users.

UMA-enabled mobile phone user will get transparent access to all the same services provided in mobile core network as using GSM or WCDMA licensed radio access. In addition to that the system provides completely transparent seamless transitions (roaming and handover) between unlicensed and licensed access networks to the subscriber.

This device and service convergence together with in-home broadband and WLAN access allows users to the same phone sets, phone numbers and mobile core network services instead of fixed line phones. For the home user it is convenient to be able to use the same wireless device with up to date mobile phone and

address book for instance at the price levels of fixed-line telephony.

UMA technology provides also improved mobile phone indoor coverage especially in North America where only limited coverage is provided in many residential areas. Extended location based services are possible since the unlicensed access point is identified together with the GERAN or UTRAN cell. The handset could for example inform the street address during its registration request to the UNC alias GAN controller (GANC). The more accurate geographic location can then be used for instance in emergency situations (Ericsson Review No. 2 2005).

UMA enables operators to use existing network infrastructure and billing systems to launch communication services over IP in end users´ homes.

In 2005, TeliaSonera started a pilot for UMA enabled handsets and access points. The pilot was conducted in Denmark with 50 families, starting from May 2005. In the first phase, the terminal was a dual mode GSM/Bluetooth handset. The pilot was deemed successful by TeliaSonera, which commented that the families appreciated simplicity and ease of use of the UMA enabled phone. In the first phase, which ended in November 2005, the pilot was conducted with Motorola supplied devices. A second test phase was started afterwards, which uses dual mode Motorola GSM/WLAN phones (TeliaSonera 2005).

5. Influences on Operator Business Models

The UMA technology is going to affect standard network operators in the future, when UMA enabled handsets become available. WLAN based access points are relatively cheap to manufacture and can be deployed widely in urban zones. This way, regular cell capacity limits and lower voice quality issues are eliminated. In the United States, WLAN coverage is often better at homes than cellular coverage (Paolini 2006).

Since providing GSM services through fixed networks is a lot cheaper than using base transceiver stations (BTSes), operators will be able to lower calling and data transfer costs for customers. If widely available, customers would be happy to conduct their calls using UMA if the prices would be as low as with fixed-line calls, which will result in more revenue per customer for the mobile operator (InCode 2005). In the US, Monica Paolini estimates that operators should offer a fixed monthly fee of 10$ for unlimited UMA calls at home (Paolini 2006). A recent study shows that about one third of mobile use happens at home, both in the United States as well as Western Europe (InCode 2005), so there is a real possibility for the operators to increase their revenues.

Additionally, the network operators are able to enter wireless broadband markets for regular laptop/PDA users as well if they are building a WLAN AP infrastructure for urban areas. The users can use the same mobile subscription for the wireless broadband, which is easy and cost-effective for both parties.
UMA is going to bring a visible boost to new bandwidth-intensive multimedia services, which normally require at least 3G speeds. UMTS base stations are expensive to install indoors, and the coverage isn't nearly as good as with GSM. Thus, fast mobile data connections will be available in more places than before, enabling users to actually use the multimedia services.

6. Vendor Strategies

The initial aim for the vendors of UMA forum was to establish standardized technology to ensure cooperation in commercialization stage of the technology, because it was crucial to provide compatibility between all manufacturers' products and prevent the emergence of multiple competing standards (Schilling 2005).

Telecomm vendors eagerly market their FMC solutions for operators. Handset vendors tend to build support for multi-radio and multi-access terminals enabling different access methods including WLAN. For example Nokia has announced that it will aim supporting both UMA and what they call Native IP access to be used with IMS (Nokia Corporation 2005). Some vendors develop their own network equipment to support UMA while some others have made strategic decision to offer them trough a collaboration partner, see Table 1.

Table 1: Announced UMA network vendor solutions (InCode 2005)

Vendor	UMA solution
Alcatel	Together with Spatial
Ericsson	Own UNC
Kineto Wireless	Own UNC
Motorola	Kineto's software, possibly own hardware
Nokia	Resells Kineto's UNC

Kineto Wireless, founded in 2001 is a vendor specialized in UMA technology development and manufacturing. Kineto, a venture-backed private company, supplies core network solutions to operators as well as client software solutions to mobile device

manufactures. It has made various collaboration agreements with many leading companies and thus enforced its credibility. The collaboration companies include handset vendors like BenQ, Chi Mei, LG, Motorola, Nokia and Samsung; semiconductor company like Philips and Texas Instruments as well as TTPCom the manufacturer of cellular software platform and protocols licensed by semiconductor and terminal manufacturers worldwide.

The UMA handsets are targeted to mid-range and low-end cost level market segments following the operators marketing strategies, but the pricing of WLAN circuits and integrating them into mobile platforms makes it likely that only high-end or mid-range terminals will appear first, followed by the low-end tiers at least a year later (InCode 2005). Table 2 shows the UMA-compliant handset situation by vendor.

Table 2: Announced handset vendors supporting UMA (InCode 2005)

Vendor	Model and availability
BenQ	P50 Pocket PC, 2005
Chi Mei	No information
LG Electronics	CL 400, 2005
Motorola	V560, Razr and A910, 2005-2006
Nokia	6136, 2006
Samsung	No information

7. Conclusion

UMA enabled handsets will be available in greater numbers very soon, complete with a very low power consuming 802.11g WLAN chips. It is unlikely to see any reasonable growth for the UMA Bluetooth markets, since the range is limited and access points aren't available (Philips 2005).

Still, it is not clear whether UMA will be a big hit or not. The operators need to have enough customers with UMA enabled handsets so that their investments to the network side would be profitable. In some countries, such as the United States, UMA is more attractive than in others, due to the worse existing cell coverage. Also, the pricing point is critical for the customers, so that they are willing to buy a UMA enabled mobile handset as well as have the additional radios switched on, sacrificing some standby time. We estimate that UMA in its current form will be properly in use, if it ever will, in around 2 years.

UMA technology seems to suite well for regular mobile network operators in their long-term mobile network evolution and it has a significant time-to-market advantage over VCC. Some new fixed-line operators such as cable-TV and VoIP providers are likely to target to IMS directly without UMA. Since IMS with VCC provides a substitute for UMA, the technology choice of operators plays a key role in how UMA is diffused. We believe that all related standard technologies will be used side by side within future mobile networks, though analyzing the overlaps between UMA and I-WLAN would need separate studies and knowledge about anticipated convergence between VCC and the most advanced scenarios of I-WLAN (InCode 2006).

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ADVANCED TELECOM COMPUTING ARCHITECTURE

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Abstract

The telecom network infrastructure manufacturing business is an oligopoly because entry barriers to telecom infrastructure equipment market are high. Entry to market requires significant investments to telecom platform. The telecom infrastructure business is facing increasing cost pressure. Advanced Telecom Computing Architecture (ATCA) is the first industry standard that specifies basis for an open standards based modular platform, on which Telecommunications Carrier Grade applications can be based on. The effects of ATCA to telecom infrastructure business are studied in this paper by analyzing ATCA implications to telecom network equipment vendor's cost structure, market entry barriers, and network operator's capital and operational expenditures.

Key Words

ATCA, PICMG, Entry Barriers, R&D Costs, CAPEX, OPEX.

1. Introduction

Telephone was invented by Alexander Graham Bell in 1876. Since the invention of telephone the manufacturing of telephone exchanges has been done by specialized telephone manufacturing companies. Telephony technology has changed many times after the invention of telephone to this day but the fact that specialized telephone manufacturer's produce the telephone exchanges has not changed.

The characteristics of the market that the specialized telephone network infrastructure manufacturers produce the telephone network equipment has caused that the industry is an oligopoly with few telecom equipment vendors ruling the industry. One of the main reasons for the oligopoly is that the entry barriers to the market have been high. The main contributor to high entry barriers are the large capital investments required to build a telecom platform. Even a company had the capital to develop the telecom platform development of telecom platform is not a trivial because it requires a set of specialized skills e.g. handling of reliability, availability and serviceability aspects effectively. There is also high risk associated to decision to start developing a telecom platform because if it fails there is low salvage value in half built telecom platform.

Advanced Telecom Computing Architecture (ATCA) is the first industry standard that specifies basis for an open standards based modular hardware platform, on which many applications can be built. ATCA is primarily focused on Telecommunications Carrier Grade applications based on standard fabric solutions. ATCA is completely based on commercial off the shelf components. The ATCA specifications are available for any company. (PICMG 2004a)

ATCA is an appealing alternative because the telecom infrastructure market is facing increasing price sensitivity. The telecom equipment vendors are seeking ways to lower their R&D to sales ratio. Network operators are seeking ways to lower their capital and operational expenditures. ATCA shows the potential to break the oligopoly of few telecom vendors and increase competition. Furthermore it has the potential to lower the development and production costs of telecom network element thus the whole telecom network. Potentially ATCA also decreases the operational costs of a telecom network.

The scope of this paper is to analyze implications of ATCA to telecom infrastructure business mainly from telecom vendor and partly from network operator perspectives. First brief overview of ATCA is given. Next the effects on cost structure of telecom infrastructure are analyzed from telecom vendor's perspective. Then effects on entry barriers to telecom infrastructure market are analyzed from telecom vendor's perspective. In the next chapter vendor strategies are discussed. In chapter 6 an ATCA based telecom infrastructure product is presented. In chapter 7 network operator view of ATCA is discussed. Finally the conclusions are given.

2. Overview of ATCA Standards

Advanced Telecom Computing Architecture (ATCA) is a series of industry standard specifications for the next generation of carrier grade telecommunications network infrastructure equipment. The base ATCA specification, PICMG 3.0, was ratified in December 2002. ATCA standards are developed by PCI Industrial Computer Manufacturers Group (PICMG) that is a consortium of over 450 companies who collaboratively develop open specifications for high performance telecommunications and industrial computing applications. ATCA is targeted to be a common hardware platform for ordinary computing and telecommunications equipment. (Alcatel 2005a) (PICMG 2006b)

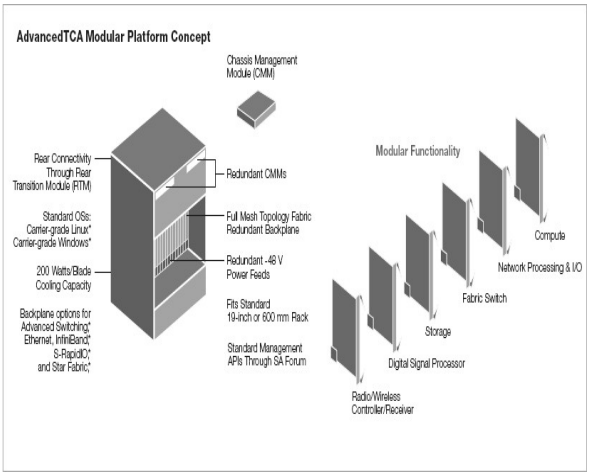

Figure 1. ATCA System Components. (Intel 2004)

Figure 1 illustrates the components needed for ATCA chassis, power supplies, Chassis Management Modules, cooling, backplane and rear transition modules. The modularity of the platform is achieved by selection of the plug-in boards based on application requirements. The ATCA backplane and the management interfaces are standardized and open thus any vendor has possibility to produce ATCA compatible boards. The boards may be tailored to Compute, Network Processing & I/O, Fabric Switch, Storage, Digital Signal Processor and Radio/Wireless Controller/Receiver. There exist various vendors of ATCA chassis components and specific boards. (Intel 2004) (PICMG 2003)

The standardized management interface is called Intelligent Platform Management Interface (IPMI), and each plug-in board implements the interface in order to monitor and control the system including power, cooling and interconnect. There are two switch interfaces to backplane the base interface and the fabric interface. The base interface offers basic connectivity and it is targeted for control plane applications. The fabric interface supports various switching technologies that are defined in PICMG 3.1-3.6, and it is targeted for data plane applications. (Heavy Reading 2005) (PICMG 2004a)

2.1. PICMG 3.0

PICMG 3.0 is the overall general specification that defines mechanics, board dimensions, power distribution, power and data connectors, and system management for ATCA. The specification does not specify the type of switching fabric instead specific fabric definitions will be undertaken on subsidiary specifications from PICMG 3.1 to PICMG 3.6. The component interoperability will be defined by the combined PICMG 3.0 core specification and a subsidiary fabric specification. (PICMG 2006a)

2.2. PICMG 3.1

PICMG 3.1 specification defines an Ethernet and Fibre Channel switch fabric over the generic backplane fabric interconnect. It provides data rates up to 10 Gbit/sec. per link. (PICMG 2006a) (Unstrung Insider 2004)

2.3. PICMG 3.2

PICMG 3.2 specification defines how InfiniBand systems are built within the architecture and will specify link physical layers, protocols, and protocol mappings. (PICMG 2006a) (Unstrung Insider 2004)

2.4. PICMG 3.3

PICMG 3.3 specification defines a StarFabric implementation over the backplane providing TDM, cell, control, and packet connectivity over the same fabric. (PICMG 2006a) (Unstrung Insider 2004)

2.5. PICMG 3.4

PICMG 3.4 specification defines how PCI Express and PCI Express Advanced Switching transport are mapped onto the generic backplane fabric interconnect. (PICMG 2006a) (Unstrung Insider 2004)

2.6. PICMG 3.5

PICMG 3.5 specification defines how Serial RapidIO transport is mapped onto the generic backplane fabric interconnect. (PICMG 2006a) (Unstrung Insider 2004)

2.7. PICMG 3.6

PICMG 3.6 defines how Packet Routing Switch (PRS) is mapped onto the generic backplane fabric interconnect. The specification is still under development. (PICMG 2006a) (Unstrung Insider 2004)

2.8. Advanced Mezzanine Card and Micro Telecom Computing Architecture

Advanced Mezzanine Card (AMC) is a modular add-on card that is connected to a carrier board that is connected to backplane of the shelf. There can be one or more AMCs connected to a single carrier board with AMC connectors. The PICMG AMC base specification, AMC.0 defines the common elements for each implementation including mechanical, management, power, thermal, and interconnect. The base specification mezzanine cards are optimized for, but not limited to, ATCA carrier boards. Subsidiary AMC specifications, AMC.1, AMC.2, AMC.3 and AMC.4 define the usage requirements for each interface implementation. Interface implementation options include PCI Express, Advanced Switching, Serial RapidIO, and Gigabit Ethernet. (PICMG 2004b)

In Micro Telecom Computing Architecture (MicroTCA), AMCs are directly connected onto a chassis backplane, without the need to be mounted on an intermediary carrier board. MicroTCA is intended to be a lower-cost version of ATCA, targeted to telecom carrier equipment outside central sites, such as remote

terminals and wireless base stations. The MicroTCA specification is still under development. (PICMG 2006c)

2.9. SCOPE Alliance

SCOPE is an industry alliance that is trying to speed up the deployment of carrier grade base platforms based on Commercial Off The Shelf (COTS) hardware / software and Free Open Source Software (FOSS) building blocks, and to promote interoperability to better serve Service Providers and consumers. SCOPE has been founded January 1, 2006 by Alcatel, Ericsson, Motorola, NEC, Nokia and Siemens. SCOPE will complement the work of industry initiatives such as PCI Industrial Computer Manufacturers Group, Service Availability Forum, Open Source Development Lab and others that have successfully created high quality open specifications. (SCOPE Alliance 2006)

3. Implications of ATCA to the Cost Structures of Telecom Infrastructure

Traditionally telecom vendors have differentiated their products through the functions of proprietary telecom platform. The Research and Development spending to telecom platform development of telecom vendors have reflected this characteristic of telecom market. When ATCA is introduced the telecom hardware platform is standard so no differentiation is achieved by telecom hardware platform. The overall R&D spending will decrease because use of standard telecom hardware platform. A special report made by RHK (RHK 2003) assumed a cost model where the target cost per board could be reduced by up to 60% in four years compared to the proprietary boards/equipment model.

Figure 2 shows the change in costs structure of telecom infrastructure. The R&D spending for proprietary hardware and software platform decreases because commercial processors and building blocks are used thus less testing and in house development is needed. The costs saved in platform development leave room for innovativeness in application software and features.

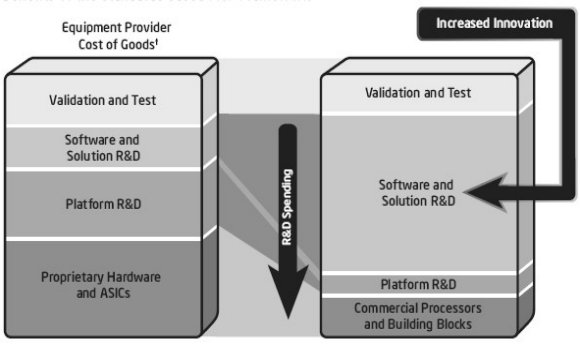

Figure 2. Benefits of standard based platform (Intel 2006)

ATCA pushes the telecom industry from traditional vertical production model, in which telecom vendors makes everything in house, to vertical production model, in which telecom vendor buys the standard components from another company. The move from proprietary in house design to purchase standard hardware and components leads to greater rationalization of the telecommunications market, as the same R&D spending from one ATCA hardware vendor can be capitalized by several telecommunications vendors. This results in increase of manufacturing volumes and results in lower prices. Figure 3 illustrates the move form vertical to horizontal production model. (Alcatel 2005a)

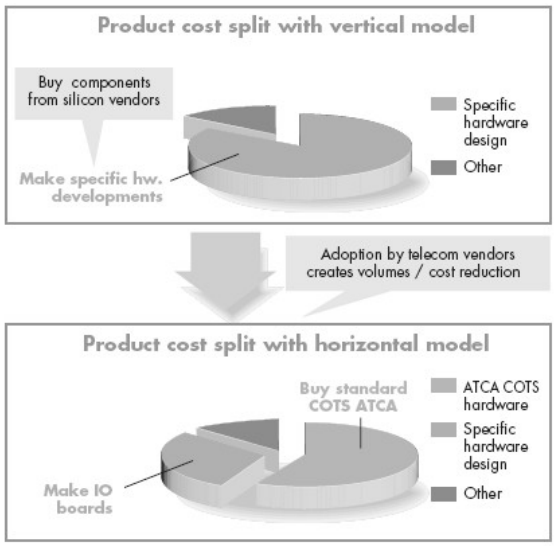

Figure 3. From Vertical to Horizontal production model (Alcatel 2005a)

Telecom vendors should not concentrate their R&D spending on parts that do not add differentiation, the standard ATCA components, because they can be bought from any of the multiple hardware vendors. There are numerous ATCA component vendors thus low cost can achieved by competition. Telecom vendors should concentrate their R&D only to the parts that add differentiation to their products e.g. specific I/O boards or user plane processing hardware. (Alcatel 2005a)

4. Implications to Entry Barriers of Telecom Infrastructure Markets

The implications to entry barriers of telecom infrastructure market are analyzed using Threat of Entry force from the Michael Porter's five competitive forces framework. The analysis is made from telecom vendor perspective.

4.1 Economies of Scale

Economies of scale are required for development and production of telecom infrastructure network elements to achieve competitive cost structure. Telecom platform constitutes large fraction of the development and production costs of a network element.

The development costs of ATCA platform will be shared by many of the manufacturers of telecom

network elements thus limited investments in development are required to obtain a telecom platform. The production costs for the telecom platform will also decrease because the economy of scale is not limited to a single vendor but economies of scale will be industry wide.

4.2 Product Differentiation

Today telecom network element products are not differentiated by the set of features because they are mainly based on standards but proprietary platform functions like sophisticated Operation and Maintenance interface. However the need for feature differentiation i.e. introduction of add on proprietary features is increasing because network operators are demanding for proprietary extensions to help their task to build differentiated services.

The ATCA hardware platform will be standard component thus the differentiation of telecom network element must be achieved by rich set of application features. The modularity of ATCA gives possibility to plug-in application specific boards into ATCA chassis. This is an enabler for product differentiation.

4.3 Capital Requirements

Today capital requirements for market entry are high because large initial investment for the development of proprietary platform for network elements is needed. Furthermore there is low salvage value in half built telecom platform.

The initial high capital investment will no longer exist because the ATCA telecom platform is available for everyone.

4.4 Switching Costs

Customer switching costs are high because switch to another supplier requires not only replacement of the equipment but also extensive training operator's personnel. The training is required because the hardware and operation & maintenance of proprietary platform are vendor specific.

ATCA will lower the customer switching costs because same hardware and management interfaces are used among all vendors. Thus it is easier to switch from one supplier to another.

4.5 Access to Distribution Channels

Incumbent players have established relationships between the customers, network operators, thus they have advantage over new entrants. However the effect of long term relationships between suppliers and customers is decreasing because the shareholders are expecting to get more and more profit. This causes that the telecom network elements are more often purchased based on lowest bid. This entry barrier is already today low and ATCA should not have significant impact on it.

4.6 Cost Advantages Independent on Scale

Telecom industry has a long history with Intellectual Property Rights. The large vendors have agreements between each other to share Intellectual Property Rights. However in telecom platform hardware technology area the number of protected assets is low.

ATCA is an open standard and the technologies used in technical realization of it are open thus there should be no barriers with Intellectual Property Rights.

4.7 Government Policy

In high penetration markets e.g. Europe governments are not regulating the market and competition is open thus government policy does not increase the entry barriers. In some low penetration countries the governments are by legislation regulating the entry to market. By requiring extensive tests on network elements until license to market is granted. Or by requiring the network element production is done in the market it is sold otherwise high protection toll must be paid. ATCA should not have significant impact on this entry barrier.

5. Vendor Strategies

In the recent years Research and Development spending has been high and continuously increasing in many telecommunication manufacturing companies that has affected negatively to profitability of the companies. One of the main reasons for this has been development of many telecommunication node platforms (Nokia Corporation 2005). ATCA has the potential to decrease R&D spending for the telecom platform. However not all telecom vendors see ATCA as potential but threat. This is because two main factors:

1. They have made significant investments to their proprietary telecom platform. ATCA might cause them to loose the capital investments.
2. They have substantial market share and are making profit from the sales of proprietary platform based network elements. ATCA might decrease their market share and profit.

Because of the two above factor vendors have selected different strategies.

Market leaders e.g. Nokia, Ericsson are continuing investments to proprietary platform because ATCA has not affected so far to their sales. They are actively following up the market, customers and participating in ATCA standardization but have not launched products based on ATCA. The market leaders are most probably looking into possibilities to evolve into ATCA in order to be ready when/if ATCA starts to affect negatively their sales but are doing this in secret.

The telecom vendors that do not have as large market share as the market leaders e.g. NEC, Alcatel are interested on ATCA and see ATCA as possibility to challenge the market leaders by means of differentiation. They have launched ATCA based products (NEC 2003) or have announced that they will

release ATCA base products in near future (Alcatel 2005b).

ATCA will enable new vendors, even small ones, to enter the market e.g. Ulticom (Ulticom 2006) and Iskratel (Iskratel 2006). New entrants will probably select low cost strategy utilizing the increasing price pressure in the telecom market because they have more competitive cost structure.

6. NEC's ATCA-based SGSN and GGSN

NEC launched world's first Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN) network elements that are based on ATCA in September 2003. Today more than 150 of them are already up and running in different commercial networks. The NEC's ATCA-based platform also employs carrier-grade Linux and NEC proprietary middleware. The high carrier-grade reliability and capabilities are offered by NEC's middleware. NEC launched the ATCA based platform to achieve a short-term product development period (1/3 of current systems), and drastically reduce product development costs by utilizing open software/hardware. The ATCA based platform realizes rich services for carriers with carrier-grade reliability, easy operation, and hight performance. Figure 4 illustrates the NEC platform architecture. (NEC 2003) (NEC 2006)

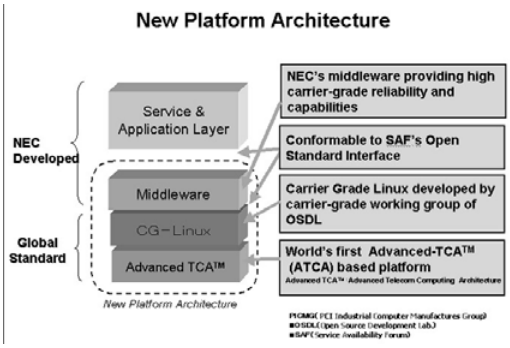

Figure 4. NEC Platform Architecture(NEC 2003)

NEC was the first in the market to launch ATCA based network element however it has not drastically boosted its overall sales (NEC 2005). NEC wisely selected GGSN and SGSN network elements to be the first network elements to utilize ATCA because they are quite new network elements compared to some other elements in the telecom network. Thus there are lower customer switching costs and less legacy dependencies associated to SGSN and GGSN that would hinder the sales.

The NEC product strategy from proprietary platform to ATCA seems like evolutionary step. ATCA based SGSN and GGSN is continuation of their traditional SGSN and GGSN product line. This is because if they would have made more revolutionary step the product would have not been ready so early. Also the utilization of proprietary middleware indicates that an evolutionary path is selected. By selection of evolutionary path NEC can benefit from the previous capital investments to the development of network element.

7. Operators

The incumbent network operators are today highly focused on how to decrease the Capital Expenditures (CAPEX) and Operational Expenditures (OPEX) in their operations because of the price pressure especially in voice services. ATCA offers the potential to decrease both CAPEX and OPEX of network operators. ATCA effects to CAPEX and OPEX of network operators are listed below:

CAPEX

- Development and production costs of ATCA based nodes are cheaper this should result lower purchasing cost per network element. In (Unstrung Insider 2004) it is stated that according to Intel executive it is possible to cut up to 35% of capital expenditures.
- Evaluation of products from different telecom vendors becomes cheaper and easier. Risk of making wrong choice decreases.

OPEX

- Supply chain will be unified that will improve manageability of supply chain, reduce spare part inventory, reduce repair costs and improve on-site maintenance capabilities.
- Reduction in training costs because less training needed for the network operation and maintenance personnel and fewer specialists needed to service a mixture of varying proprietary hardware architectures.
- Consistency in human interfaces and operation of systems around the network that enables greater efficiencies in overall operating processes
- Uniform network element layouts and maintenance practices will decrease labor costs.
- Smaller footprint and reduced power consumption will decrease rental and electricity costs.

(Alcatel 2005a) (Intel 2004) (Unstrung Insider 2004)

Even ATCA shows the potential to decrease CAPEX and OPEX the incumbent operators that have recently made significant investments to network infrastructure are not rushing to ATCA because they want to utilize the already made investments to the network infrastructure. Thus ATCA based nodes will not be common in incumbent operator's network until the next network modernization phase e.g. (British Telecom 2004) or next generation mobile system is launched (3GPP 2006).

However the Greenfield operators are interested on ATCA based nodes because ATCA offers them significantly smaller CAPEX and OPEX compared to incumbent operators, their competitors. They can enter the market with smaller capital investments and they can select the cost leadership strategy exploiting lower OPEX to conquer the market.

8. Conclusion

ATCA enables costs rationalization for both telecom vendors and network operators and thus it is an answer to increasing market price sensitivity. ATCA enables telecom vendor's to lower their R&D to sales ratio and it enables network operators to lower the capital expenditures and operational expenditures. ATCA lowers the entry barriers to telecom infrastructure equipment market thus it will break the traditional

oligopoly of telecom network equipment market. This causes more competition in the market and lowers price levels.

However the telecom infrastructure market leaders are still waiting to see will ATCA take off. They are continuing development of proprietary platforms and the incumbent network operators are continuing investment on equipments based on proprietary platform. If ATCA takes off the market leaders should introduce the ATCA as a continuation of their existing product line because they can benefit from the previous capital investments to the development of network element. First ATCA based network elements could be packet core nodes GGSN and SGSN because the customer switching costs are lower in those nodes.

The new entrants in both equipment vendor and operator markets have the momentum to attack the market leaders now by quickly introducing ATCA based products and networks. They can utilize the substantial cost benefits as the weapon. However there is always a high risk associated introducing new technology first but there is potential to make big wins.

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OPERATOR STRATEGIES FOR MOBILE INSTANT MESSAGING

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Abstract

Instant messaging has become a huge success in the fixed Internet. Simultaneously, other forms of messaging are also popular in the mobile world. This suggests that mobile instant messaging may well be a latent customer need. This paper studies the current state of instant and mobile instant messaging market, and analyzes the possible strategies for a mobile phone operator to employ in it. The balance between cooperation and competition with the other players (other operators, fixed Internet IM services and manufacturers) is very delicate in this market.

Key Words

Mobile instant messaging, instant messaging, operator strategy, network effect.

1. Introduction

Instant messaging (IM) means such communication service in which the users are able to communicate with each other in writing in real-time. Communication may happen either between two users or within a bigger group. Most IM services also include presence information features, meaning that they are able to show status information about the users, for example, whether a particular user is available for a chat or not, or if she is not even online at all.

IM complements the palette of other communication mechanisms, allowing faster response than e-mail but yet not requiring as intensive attention as a telephone call. It is little by little establishing a permanent position as a means for communication. IM's strongest position is in the consumer market even though the number of business users is increasing. In the consumer market, IM is mostly used for keeping in touch with friends or family, even though the IM services also have different search tools for searching new friends (that e.g. share same hobbies) to chat with.

IM has become one of the most popular applications in the fixed Internet. In year 2004, the user base of IM reached 260 million and was still rapidly growing (Salin 2004). Simultaneously, also short messaging system (SMS) messages have gained huge popularity in the mobile telephone networks. Popularity of SMS suggests that also a more advanced mobile messaging service like mobile instant messaging (MIM) may well be a latent customer need.

As the mobile phone network operators are currently very focused on finding new services to the mobile market, they would be more than happy if MIM turned out to be the new SMS. Hence, this paper will study different possible operator strategies for competing in the MIM service market.

The paper is structured as follows: First, section 2 explains the current situation in the IM market. After that, section 3 presents the possible operator MIM strategies, section 4 further discusses the strategies, and finally, section 5 give our conclusions.

2. Landscape

This section explains the current situation in the IM market, covering both the fixed Internet IM market and the existing MIM market.

2.1 Fixed Internet IM Market

Currently, the most significant competing fixed Internet IM services are AOL Instant Messenger (AIM), ICQ, Yahoo Messenger, MSN Messenger and Google Talk.

AIM and ICQ are both owned by AOL. Originally ICQ service belonged to Mirabilis, but the company was acquired by AOL in 1998. Nowadays, AIM and ICQ both employ the same proprietary OSCAR protocol and are compatible with each other. In 2004, the active user base of AIM is 53 million whereas ICQ's is 15 million (Nielsen/Netratings 2005). Together it means user base of nearly 70 million for AOL.

MSN Messenger is the IM service of Microsoft. It uses a proprietary Mobile Status Notification Protocol (MSNP). Its active installation base is 29 million (Nielsen/Netratings 2005).

Also Yahoo Messenger uses its proprietary standard, YMSG protocol. User base of Yahoo Messenger is about 21 million.

Google Talk is an exception from the other IM services with its open XMPP/Jabber protocol. Current user base of Google Talk is still small, but its strategy is to gain user base by encouraging other XMPP/Jabber compatible IM services or clients to interoperate with its network.

Finally, Internet Engineering Task Force (IETF) has developed an open Session Initiation Protocol (SIP)

based IM standard called SIP for Instant Messaging and Presence Leveraging Extensions (SIMPLE).

Table 1: Active user bases of fixed Internet IM services

Alliance	Service	User base of service	User base of alliance
AOL	AIM	53	68
	ICQ	15	
Microsoft and Yahoo	MSN Messenger	29	50
	Yahoo Messenger	21	
Google	Google Talk	small but growing	small, but growing

All the IM companies have been very reluctant to let others to interoperate with their service (and hence to profit from their user base). However, the companies are starting to realize the importance of a large total IM user base. Microsoft and Yahoo have announced that their MSN and Yahoo Messengers will be compatible in summer 2006 whereas Google is establishing interoperability with AIM and ICQ.

2.2. Existing MIM Market

As we argued in the introduction, the potential need for MIM is very clear. The IM companies are already formulating their mobile strategies, most of them having introduced a mobile version of their IM service.

Yahoo has launched its Yahoo Mobile, offering an SMS based and a mobile web browser based Yahoo Messenger client. The service works independently from operators. Charging is based on operator wireless data plan. In other words, an operator is a plain data carrier and gains no extra revenues for enabling the MIM service. (Yahoo Mobile 2006)

Similarly AOL offers an SMS based mobile access to its AIM network and also a real mobile AIM client. AOL is also cooperating with some US mobile operators, which provide a pre-installed mobile AIM client. Basically pricing is based on wireless data plan. (AIM 2006)

For Google Talk, third parties, like BlackBerry, have launched compatible (XMPP/Jabber) MIM clients. Mobile Google Talk is likewise independent from the operators.

Simultaneously with fixed Internet IM service mobile expansion, Open Mobile Alliance (OMA) has introduced a set of specifications for MIM called Instant Messaging and Presence Service (IMPS) (OMA 2006). The standard is often referred as "Wireless Village" (WV). OMA is a standards body formed by many large mobile operators, mobile equipment manufacturers and software vendors. IMPS as well as SIMPLE are applicable for both mobile and fixed environments.

3 Operator Strategies

IM is a classical example of a technology in which network effect takes place. Network effect means that the more a technology has users the more it has value for them. Telephone network is a good example of technology with network effect; the more users a telephone network has, the more persons one is able to reach by means of telephony. Hence, the technology is the more valuable for the users as they can reach many people with it.

However, the case MIM is just a bit more complicated. As in the previous example, the more MIM users there are, the more people they are able to reach by using MIM. Yet, possibility for interoperability with fixed Internet IM makes competitive environment more complicated.

We believe that the MIM users would not only valuate communication with other MIM users, but also with the fixed Internet IM users. Hence, an operator has two different dimensions on which to seek interoperability: other operators and IM services of the fixed Internet.

Figure 1 summarizes the four possible strategies resulting from the dimensions. An operator can seek interoperability purely with other operators, purely with fixed Internet IM services, simultaneously with both of the previous, or it can establish its own closed proprietary MIM standard. These are rather components of strategies than strategies to strictly follow, as will be explained later. Next, we will cover the different strategies with more details.

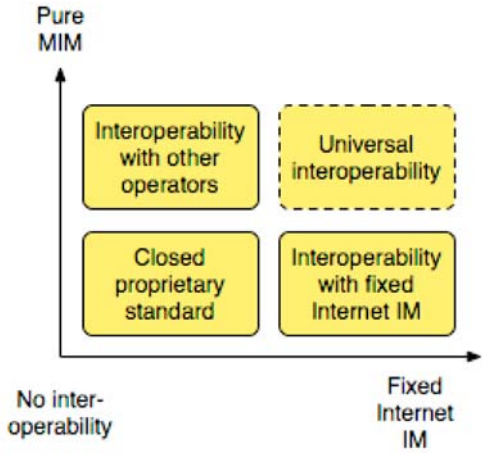

Figure 1: Operator MIM strategies

3.1 Interoperability with Other Operators

The most natural way for the operators to expand user base of MIM is to establish interoperability between

each other. Firstly, the total connectivity offered by MIM increases when customers of different operators can reach each other, and hence, the service is found more valuable by the customers. However, interoperability between operators is attractive also for other reasons.

First of all, the operators employ similar business models. It is easier for two mobile operators to establish a common service, than it would be for an operator and a fixed Internet IM company. Many IM companies get their revenues indirectly from advertisements unlike the operators that employ direct charging.

Secondly, a purely mobile IM service would also allow developing the service from a mobile perspective. The mobile environment differs from the fixed Internet also in the device capabilities. On the one hand, the mobile devices are limited in their I/O capabilities, but on the other hand, they also have capabilities like mobility and ability to produce location data, which could enable versatile services. It is easier to develop a service for a relatively homogenous user interface.

The work for MIM interoperability has already begun, OMA IMPS being the most visible effort towards it.

3.2 Interoperability with Fixed Internet IM

There are two aspects in interoperability between MIM and fixed Internet IM. Firstly, if a MIM service is compatible with existing IM services, it gains the advantages of a large network for free. There is already a large amount of fixed Internet IM users to communicate with even if the amount of mobile users were small.

Secondly, it is likely that those same people that are already using normal IM are the ones who are also the most promising target group for MIM services. In situations like this, Varian et al (Varian 1999) emphasize the importance of offering a smooth migration path for consumers. In other words, an operator could gain the existing IM users to its customer base by offering sufficient interoperability with their existing service.

Because of these two factors, interoperability with fixed Internet IM can offer competitive advantage for an operator.

The most basic form of this interoperability would be naturally the ability to send messages between mobile and fixed networks. Examples of other elements of interoperability are:

- Using same account
- Using same buddy list
- Passing presence information between fixed and mobile networks

The easier it is to migrate from fixed Internet IM to MIM, the more users will choose to do so. Yet, the strategy has still its challenges.

First of all, as mentioned earlier, mobile devices are still very limited in their capabilities (e.g. small display and slowness of text input). It is unrealistic to assume that the fixed Internet IM users would completely migrate to MIM in the near future. For them, MIM is rather such addition to the normal IM service that allows usage of service also in mobile settings, not a substitute to the original service.

Secondly, establishing interoperability may be difficult, as there is no single dominant fixed Internet IM service (Salin 2004, Nielsen/Netratings 2005). Instead, an operator should separately seek compatibility with each service.

The companies offering IM services have been very reluctant to establish compatibility even between their services, and so this strategy may be difficult. It is unlikely that after refusing to establish interoperability with each other, the IM companies would suddenly all accept to interoperate with some mobile IM service.

However, it is possible that one or even a few of the largest IM services would be interested in a partnership with an operator. Partnership with an operator would allow also the IM service to enlarge its user base and, most importantly, improve the service that is offered to its customers as they could use the service also in mobile settings.

There are different possible forms for the partnership:

- The operator and the partner share a standard (e.g. open standard, common proprietary standard, mobile version of fixed Internet IM service standard or operator's proprietary standard)
- The different standards are made interoperable through a gateway/proxy

OMA has paid special attention on the ability for an IMPS network to interoperate with other IM networks. The IMPS architecture includes a gateway that can be used to connect the network to other IM networks.

3.3 Universal Interoperability

Naturally, an operator can also simultaneously seek for interoperability with as many other operators, and as many fixed Internet IM service, as possible. This strategy would maximize the connectivity offered by the MIM service. Universal interoperability may yet be an utopia but it is still a good goal to strive for.

As this "strategy" is only a combination of the two previous, we will not count it as a strategy of its own.

3.4 Closed Proprietary Standard

Instead of seeking interoperability, an operator has one final strategy left. It can establish its own proprietary MIM standard. The problem is that then the operator cannot utilize any existing IM networks and hence gaining positive feedback from network effect is harder. On the other hand, the operator has total control over the standard, and it can gain customer loyalty (lock-in) by being the only operator offering a particular MIM service. For example, Finnish mobile phone operators have long looked for this kind of services to increase customer loyalty.

Yet, the downside of this strategy is that an operator has to carry the risk of developing and launching a standard alone. Furthermore, competition with other standards may be hard, especially if other standards have larger user bases. A larger user base means a larger value of network. Hence, an operator using the proprietary standard strategy has to either have an existing sufficiently large customer base or offer such technologically superior standard that can compete even with larger networks.

However, an operator can utilize this strategy also partially by making proprietary modules to an open MIM standard. This way it can get the best of both open standard and proprietary standard strategies: a large market but simultaneously control and customer lock-in. Varian et al (Varian 1999) recognize this delicate balancing between cooperation (open standard) and competition (proprietary modules) as *coopetition.*

4. Discussion

The fight for MIM market is already begun. Fixed Internet IM services as well as operators are establishing their positions in it. Due to their existing user base, the fixed Internet services are currently in a better position. Partly this is because the operators have been reluctant to cannibalize their lucrative SMS business with MIM. Now, however, as also the fixed Internet IM services are going mobile, it is the latest moment for the operators to act if they want to be in the MIM business.

All of the strategies (or "components of a strategy") presented in the previous section are applicable for an operator. As a matter of fact, we recommend an operator to employ all of them.

Firstly, a common standard for MIM helps to establish a true MIM market with a sufficient user base, not just an extension to the fixed Internet IM services. It also sets the alliance, as a single larger IM player, into a better position when negotiating for interoperability with fixed Internet IM services. OMA IMPS seems to be a promising candidate for a standard in this category.

However, an operator is able, simultaneously with this strategy, to seek for interoperability with individual fixed Internet IM services. If an operator succeeds in establishing such interoperability the other operators are not capable of, it can gain customer loyalty. For example the IMPS architecture is designed so that interoperability with other IM networks is possible.

In addition, an operator can gain further customer lock-in by differentiating through proprietary extensions to the common standard.

4.1 Pricing

A problem for the operators is that a MIM service can be implemented over their plain data services without them explicitly enabling the service. Many of the current MIM services are operating like this.

This makes it hard for the operators to justify premium prices for their own, or especially for IM service provided by some another instance (e.g. a fixed Internet IM company). Yet, if premium pricing cannot be applied, the only benefit an operator gets is increase of data traffic. An operator should strive for a position where it can apply premium prices or otherwise there is a risk that it will become a plain data carrier.

Premium pricing would be psychologically more acceptable to the customers if the operator itself provided the MIM service, or even better, provided better MIM service than the others are providing.

Hence, pricing presents another reason why an operator should primarily try to establish a common good MIM standard with other operators having similar business models, and only then seek for interoperability with the fixed Internet IM services. Yet, cooperation with the fixed Internet IM companies must not be forgotten because open competition with their user bases may be hard.

4.2 Cooperation with Manufacturers

Another important player in MIM markets are the devices manufacturers, which affect to the market in many ways. Importantly, the manufacturers decide what kind of mobile devices there are available for the consumers. Currently, the devices support IM only hardly sufficiently due to their I/O limitations. The better devices would better enable MIM and would thus have positive effect to the market. The operators should cooperate with the manufacturers to help them to create devices that better support MIM.

More importantly, the manufacturers also dictate what software is installed into their devices. Installation and configuration of new mobile device applications is still challenging for an average user. That is why preinstalled and configured IM applications could greatly help a MIM service to gain user base. An operator should seek for opportunities to make its service better available for the potential users.

4.3 Competing Technologies

As mentioned in the introduction, IM complements the palette of other communications mechanisms. Yet, MIM still have competing technologies, most importantly SMS, mobile e-mail and mobile telephone calls.

MIM has its own segment between telephone calls and e-mail. It cannot compete with telephone calls in their speed of interaction but yet it allows much quicker interaction than e-mail. MIM is also much more discrete than a telephone call, and hence maybe more suitable for example in meetings or public places. However, competition occurs on the borders of the segment.

On the other hand, the previously described characteristics are also those of SMS. SMS is clearly a more direct competing technology. Yet, the capabilities offered by SMS are inferior to MIM, as it is only capable of changing simple (and short) messages. It is very probable that increase of MIM market share would simultaneously mean decrease the SMS market share. This explains why the operators, being afraid of cannibalizing their SMS revenues, have not so far been very active in introducing MIM services.

5. Conclusions

In this paper, we have studied the current state of the MIM market, and strategies for a mobile phone operator to compete in it. We recognized the three strategies an operator can employ in the MIM market; establishing interoperability with other operators, establishing interoperability with fixed Internet IM services and establishing a closed proprietary standard. However, we ended up suggesting employing all of them simultaneously by combining them into a single strategy.

Nevertheless, as argued, balancing cooperation and competition with the fixed Internet IM companies is a delicate issue. On the one hand, they are threat to operators' MIM services, but on the other hand, they hold significant existing user bases, which can accelerate the adoption of MIM.

The IMPS standard of OMA supports all of the recognized strategies as it establishes a common standard for the operators and enables interoperability with other IM networks. Hence, we see that of the current standards, IMPS is the most advantageous for an operator to employ. Nevertheless, the important thing is to establish a common standard, the final choice of the standard being less important.

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IPSEC BUSINESS

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Abstract

The Internet Protocol (IP) is insecure. Secure Internet Protocol (IPsec) is used to authenticate and encrypt traffic in IP networks. This paper examines IPsec from a techno-economic point of view. First the features and recent changes of the technology are studied. Then IPsec's role in securing traffic in mobile telecommunications networks is introduced. In the market overview, the main end-user categories are identified. The target market varies from simple consumer devices to advanced tailored systems for enterprises and government agencies. Since vendors can take several roles in a software industry, both software component manufacturer and system integrator roles are examined. As a result, differentiation is identified as a suitable vendor strategy and characteristics for product line differentiation from an IPsec vendor point of view are discussed.

Key Words

Software component manufacturing, IPsec, IP Convergence, Differentiation strategy

1. Introduction

All Internet traffic uses the Internet Protocol for data transfers. The traditional IP network is like a town hall where your secrets can be heard. IP packets can be forged, modified and inspected as they pass through the IP network.

To tackle these problems, the Internet Engineering Task Force (IETF) has released a set of Request For Comments (RFC) that form the IPsec protocol. It can be used to protect all traffic that uses the IP protocol, including application and transport layer protocols.

The IPsec business has evolved in the past few years significantly. New versions of the IPsec standard family address such issues as robustness and reliability. Through IP convergence, the IETF-driven standard has been taken into use in new scenarios, such as in mobile telecommunications networks.

There are several roles to take in the software industry value network. How do these different actors influence the original software component manufacturer? What does an IPsec software vendor have to take into consideration when planning a product strategy for these markets?

2. IPsec Technology Overview

The IPsec security architecture is a suite of protocols that provide access control, data source authentication, integrity, confidentiality (encryption) and protection against replay attacks at the IP layer. This is achieved by using traffic security protocols and cryptographic key management procedures and protocols. An overview of the IPsec security architecture is described in RFC 4301 (Kent & Seo 2005). IPsec is mandatory in all IP version 6 (IPv6) implementations but optional in IP version 4 (IPv4).

Although cryptographic keys can be configured manually, the Internet Key Exchange (IKE) protocol is used to provide authentication and key exchange services. It is used to negotiate IKE and IPsec Security Associations (SA). The IPsec SA provides all relevant information needed to do IPsec processing on an IP packet: how to protect the traffic, what traffic to protect and with whom the protection is performed. Because of its numerous features, IPsec can be used to protect traffic in several scenarios.

2.1. Use Case Scenarios

IPsec can be implemented by a host, security gateway (router, firewall) or a separate network device. IPsec is commonly used between two hosts, between a host and a security gateway or between two gateways that divide protected and unprotected parts of a network from each other. A widely known application of this is a Virtual Private Network (VPN) scenario, where two separate networks are connected to each other through an IPsec tunnel. VPN gateways are used to allow traffic that originates from or is headed to outside of a network. This way only authorized entities can access the network, and all traffic can be encapsulated in an IPsec tunnel. Common deployment scenarios are site-to-site and remote access configurations, which are both introduced in detail in Doraswamy & Harkins (2003 pp. 177-182).

2.2. Recent Technological Changes

IPsec can be used in various situations with many different options. The original IPsec standard, security architecture introduced RFC 2401 by Kent & Atkinson (1998), consisted of several RFCs, each describing a single element of the system.

According to a controversial article by Ferguson & Schneier (1999) it was not possible to build secure implementations of IPsec with current methodologies,

because of the inherent complexity of the system. Their proposals included, among others, to eliminate overlapping features from the standard set. These omissions could have been done without losing too many capabilities. Another identified area for improvement was the amount of messages needed for an IKE negotiation. A set of security weaknesses were also pointed out. The authors did however conclude that despite its weaknesses IPsec was the best method available for providing network level security.

Apparently, Ferguson and Schneier were not the only ones to criticize IPsec. An opinion shared by many is that the plethora of features is a result of the use of committees to create RFCs. When multiple interest groups are present, it is not possible for a working group to accommodate everyone. This leads to compromises between network systems design and cryptographic protocol design. (Dunbar 2001)

The current set of IPsec protocols that were introduced in RFC 4301 aim to address these issues. There are numerous differences to RFC 2401. To mention a few, several clarifications are made and overlapping features handled. The text has been amended to say that the document assumes use of IKE version 2 (IKEv2) or an SA management protocol with comparable features. The reason for this is that IKEv2 has numerous improvements over IKE version 1 (IKEv1). These will be discussed next.

2.3. Internet Key Exchange version 2

Main improvements from IKEv1 to IKEv2 are as follows: the entire IKE protocol is now described in one document, eight different initial exchanges are replaced by a single four-message exchange, number of possible error states have been reduced by making the protocol reliable (all messages are acknowledged), robustness has been increased by not doing significant processing on received messages without further inspection, and the maintenance of shared state during failures has been simplified. (Kaufman 2005.)

Although the use of IKE was traditionally limited to certain scenarios, it had been designed to suit all cases where a reliable key exchange protocol was needed. In fact, both versions of IKE are now used to secure IP traffic in mobile telecommunications networks.

2.4. IPsec in mobile networks

IPsec has been deployed by The 3rd Generation Partnership Project (3GPP), a collaboration agreement that brings together a number of telecommunications standards bodies, to implement IP layer security in 3GPP networks. IPsec and IKE are part of the 3GPP Release 6 specifications that can be found at the partnership project home page (3GPP 2006.)

There are multiple uses for IPsec in 3GPP networks. The 3GPP Technical Specification (TS) 33.210 states that in the network domain, IP layer security between network elements is implemented with IPsec and IKE. IP-based services such as IP Multimedia Subsystem (IMS) need IPsec to encrypt insecure protocols like the Session Initiation Protocol (SIP). In TS 33.203 IKE is used to mutually authenticate the subscriber and the IMS. When the 3GPP network must interwork with Wireless Local Area Network (WLAN) technologies on the IP layer, TS 33.234 states that IPsec and IKEv2 are used to provide user and network authentication, key management, service authorization, confidentiality and integrity protection of user and signaling data. Here WLAN stands for all relevant wireless radio technologies used to transfer IP datagrams, such as IEEE 802.11b and Bluetooth.

Another significant application is the use of IPsec in Unlicensed Mobile Access (UMA). With UMA it is possible to handover between Global System for Mobile Communications (GSM) or General Packet Radio Service (GPRS) network and unlicensed wireless networks, such as Wireless Fidelity (Wi-Fi) and Bluetooth. UMA delivers Fixed Mobile Convergence (FMC) services to users with a dual-mode handset. 3GPP has included UMA in their set of specifications with the title Generic Access Network (GAN) in TS 43.318. In this scenario, the mobile station uses IKEv2 to negotiate an IPsec tunnel with the GAN Controller (GANC) security gateway. This tunnel is then used to secure all traffic that is sent through a virtual interface with IPsec encryption. The authentication credentials can be retrieved from a Subscriber Identity Module (SIM) card. The procedure is similar to TS 33.234. GAN simply provides the same functionality in legacy 2G networks, and in principle the only new network element needed is the GANC.

3. Market overview

IPsec industry follows the layout of roles in software component business in general. There are roughly three roles to take. The software industry supplies software components for the use of system integrators, such as telecommunications and electronics industry. The end-products are supplied to other industries and consumer markets (Helander 2004 p. 67). However, a single corporation can act in several roles in such a business ecosystem. This value network is now examined starting from the end-user market.

3.1. End-user market segments

For the consumer market, IPsec is embedded in different network equipment, such as network cards, firewalls, broadband modems and WLAN routers. IPsec client software is sold for remote access purposes.

For the Small and Medium-sized Enterprise (SME) markets, different security gateway products are provided to divide the company network from unprotected Internet. Intranet and extranet services can be built with IPsec tunnels created with VPN gateways and IPsec capable devices. Recently, the focus in securing company networks has been shifting towards a more complete solution. To secure company internal information also laptops, smart phones and other networked devices should be taken into account when planning the security policy. A recent development in

the market has been the announcement of IPsec capable printers and printer servers (Hewlett-Packard 2005).

The enterprise market has more requirements in terms of speed, reliability and number of concurrent users. The used interfaces have more bandwidth and most devices are installed in parallel to support failover. In case of telecommunications industry and 3GPP networks, IP layer communication paths between network elements are secured with IPsec, both in the core network and towards the mobile station. For high-end devices, the low-level cryptographic and packet processing operations can be accelerated with Network Processing Units (NPU) and cryptographic accelerators.

In addition to enterprises, governments need secure networks to restrict access to personal records and confidential information. The purchasing process differs between nations, but usually suppliers make offers based on a requirements specification provided by the customer. According to Owen (2003) a large share of government business is not contracted out at all in the United States; instead, through the General Services Administration (GSA) and other government bodies, companies sell directly to agencies without having to go through formal bidding process. Approximately 28 percent of federal IT spending flows through an online IT catalog, which is run by GSA. Another important aspect in selling to US government is compliance with Federal Information Processing Standards (FIPS).

The above-mentioned end-user markets are served by different system solution providers, also called system integrators (SI) or original equipment manufacturers (OEM). These vendors can be divided to different business customer segments.

3.2. System integrator market segments

Kotler & Keller (2005 p. 216) have identified different ways of defining business customer segments. One approach is to divide them into four types: price-oriented customers, solution-oriented customers, gold-standard customers and strategic-value customers.

In the price-oriented segment, price is everything. In the IPsec industry a common scenario could be such where the security protocol is needed for a small task only and it plays a minor part in the overall capabilities of the end-product. In addition, the use case might not be as demanding in terms of bandwidth, speed and number of features.

The solution-oriented customer segment wants lower prices, but the product must meet their specific use case scenario. They will also respond to arguments about lower total costs generated by upgrades, maintenance, technical support and training.

Performance, product quality, conformance to standards, professional technical support and reliability are key features for the gold-standard customer segment. This segment is interested in IPsec product features such as support for external cryptographic hardware and reliability during high-load situations.

The strategic-value customers want to take the closeness of the supplier relationship a bit further. They look for a fairly permanent sole-supplier relationship. The IPsec vendor could for example end up implementing unique features, such as support for proprietary algorithms, for their strategic partners. For these customers, the investments made are substantial and the technology life-cycle spans further, so the supplier must be able to make long-term commitments.

For small vendors, engaging in such a relationship poses a threat. In addition to threat of vertical integration, there are players in the telecommunications industry that continuously seek for new growth opportunities. For example, Cisco Systems has a history of growth through acquisitions (Killick, Rawoot & Stockport 2001).

System integrators license or purchase software from original software component manufacturers. In the IPsec industry, this is the original IPsec product vendor. The IPsec components are further developed and integrated into the system integrators' own software and hardware platforms that are used to build end-products.

4. Software component manufacturing

Rajala et al. (2001) have used numerous sources to develop a framework for analyzing software industry. First of all, software product business has special characteristics. A software product is not a physical, but an information product. Creating the first copy of a product requires fixed research and development costs that are also largely sunk. These sunk costs have to be paid up front, mostly in terms of employee salaries. In case of a product failure these sunk costs cannot be recovered. This means that each new software product development project involves a significant risk.

However, even though a digital product is expensive to produce, the cost of producing consequent copies is very low. This means that the more licenses a software component vendor is able to sell, the lower is the average cost of production. When the same product is sold to multiple customers, the price can be set lower than the customer's own matching development costs. It is also easy to make a marketing argument that the amount of employee training needed takes less time than the customer's own development time. Therefore, a pricing scheme based on marginal costs is not applicable for this class of products.

Shapiro & Varian (1999 pp. 22-5) conclude that markets for information will not and cannot look like perfect competitive markets. There are many suppliers offering similar products each lacking the ability to influence prices. However, large fixed costs and small incremental costs (substantial economies of scale) are hardly unique to information goods. Many other industries, such as telephony, share these characteristics.

We must not forget that the program code written for sale is only the tip of the iceberg and a great deal of value is created when the software is integrated with its environment and maintained. The system integrators might need training services for their staff before they can successfully take the software component into use. To maintain competence, professional technical support services must be in place. The software vendor must also provide software upgrades and product maintenance for a significant amount of time. This service aspect of the software business no longer obeys the economic laws related to information products.

Software has two distinct kinds of economic value: the use value is its economic value as a tool and the sales value is its value as a sellable commodity. Since different customers have different valuations for the same product, and thus have different willingness to pay, it is possible to use variable pricing strategies. Software products are also quite easy to differentiate and several versions of the same software, for different target groups with specific needs, can be created. (Rajala et al. 2001.)

5. IPsec vendor strategies

According to Shapiro & Varian (1999), to serve software markets, the supplier has to choose from two basic strategies: differentiation and cost leadership. In a differentiated product industry, there must be added value to the raw information sold. In a dominant firm industry, the strategy should be to achieve cost leadership through economies of scale and scope. The latter option does not apply well for vendor markets that do not have the characteristics of a mass market. This applies to the IPsec industry as well, although by now IPsec is commodity technology with end-products supplied by a number of firms, such as Cisco Systems, Microsoft, Nokia and D-Link (VPNC 2006).

According to McGrath (2001 pp. 157-164), product differentiation combined with price define the relative positioning of competitors in a marketplace. The success of differentiation varies by each market segment as each segment values a particular vector of differentiation. This vector provides a path for continuous differentiation in a specific direction. The selected differentiation strategy should cover all primary targeted market segments.

If taken into account in early stages of the development process, a software offering can be easily differentiated into several versions. A common approach is to sell both a high- and low-end, or value-subtracted, version of a product (Shapiro & Varian 1999 p. 63). When the vector of differentiation has been selected, it is possible to create a product line that serves the targeted market segments.

5.1. Product line differentiation strategy

In a product line strategy, each product offering varies from others by specific characteristics. Such characteristics could be: capacity, performance, features, quality and configuration (McGrath 2001 p. 106). An IPsec vendor should consider all of these characteristics when planning a product line.

Features are the most natural way of differentiating a software product. In an IPsec product there are options to support only a certain number of features that are required by the RFC specifications. These include different algorithms, protocols and amount of robustness. Also, since the RFCs, especially drafts, are constantly changing, conformance to several different versions of the RFCs can be considered a feature. A practical example of this approach is to support the IKEv2 protocol in both high- and low-end versions, but to have fallback support for IKEv1 only in the high-end version.

Depending on the use case requirements, it is possible to downgrade the capacity characteristic. For example client software used for remote access purposes only needs to handle one IPsec tunnel.

IPsec performance is affected by the amount of processing power. Multiprocessing capabilities could be dropped or the number of used cores could be limited in the low-end version.

Since there is no real reason to downgrade software product quality, it is more appropriate to examine the quality characteristic on the service side. For example technical support can be offered with different service levels based on the delay between the initial support contact and the answer. Premium customers could call a telephone hotline for immediate assistance, while others send their questions through email.

It is also possible to provide the product in different configurations, such as fitness for a particular purpose. An example could be a product for VPN gateways, in contrast to a mobile phone IPsec client. Different configurations could also be created through localization.

In addition to the primary products in a product line, add-on products, such as cryptographic accelerators or key management software, may also be part of a product line. The same applies for product upgrades and custom products and features, such as support for proprietary protocols.

An overview of the different elements contributing to the IPsec software component vendor strategy is shown in (Figure 1).

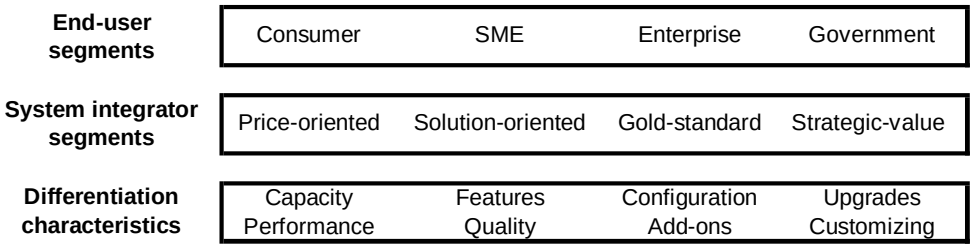

Figure 1: Overview of the IPsec vendor strategy elements

6. Conclusion

The IPsec family of standards currently provides the best available IP layer security. It is an official standard by the IETF, published in several RFCs. IPsec is a fundamental part of IPv6, and optional in IPv4. The original standard set was criticized over its complexity, and some improvements have been made to current versions of the RFCs.

IPsec provides data source authentication, integrity, confidentiality (encryption) and protection against replay attacks. It is widely used in different VPN scenarios, and recently, in mobile telecommunications networks.

For the consumer market, IPsec is integrated in network equipment such as broadband modems, WLAN routers and secure network cards. For remote access purposes, client software is sold for all major operating systems (VPNC 2006).

For the SME market, IPsec can be used to secure corporate networks, create extranet services and permit remote access to protected parts of the network from unprotected Internet. The enterprise market has similar use cases with SME, but the devices must have larger throughput and handle more concurrent users.

In mobile telecommunications networks, IPsec is used to secure IP layer traffic in the core network and between security gateways and mobile stations. IPsec client implementations are needed in mobile phones to support secure WLAN access to 2G and 3G network services.

When selecting a strategy, the IPsec software component vendor must also take into consideration the different system integrator market segments. These do not go hand in hand with the end-user markets. These market segments have different valuations for different characteristics of the product and thus have different willingness to pay.

Since it is easy to provide multiple versions of the same software, differentiation strategy was proposed as a suitable IPsec vendor strategy to serve the identified markets. The success of differentiation varies by each market segment as each segment values a particular vector of differentiation.

When implementing such a product line strategy, each product offering varies from others by specific characteristics. Examples of an IPsec vendor's selection of characteristics are capacity, performance, features, quality, configuration, add-on products, product upgrades and custom products.

IPsec market has recently grown through standardization processes and introduction of secure network equipment. In the future, when IPv6 is taken widely into use, all network elements must support IPsec. The significance of IPsec is bound to grow even further.

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INTERNET BUSINESS MODELS IN MOBILE

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Abstract

Internet has given rise to new kinds of business models and reinvented some of the already existing ways of doing business. Traditional mobile operators are now facing the same disruptive threats as the traditional industry players were facing when Internet companies emerged in their territory. The new ways of doing business have to be taken into accord or the operators will risk becoming just bit-pipes for advanced services offered by more innovative and flexible Internet companies.

Mobile environment has its own characteristics, limitations and opportunities though and the business models can't be transferred as they are. This paper concentrates on studying the primary characteristics of these business models through examples and what has to be taken into accord when transferring them to the mobile environment. And how all this could affect the existing operator business.

Key Words

Business Models, Internet, Mobile Environment, Disruptive Business Models

1. Introduction

A business model can be explained as "A description of the operations of a business including the components of the business, the functions of the business, and the revenues and expenses that the business generates" (InvestorWords.com, 2006). So basically a business model contains all the information and methods of doing business that the company can sustain itself and generate revenue. Internet has given rise to new kinds of business models and reinvented already existing traditional models such as brokering; in particular auctions. The Web has made the auction model popular and the model has been applied to even broader selection of goods and services than before. Some of the traditional businesses were threatened when these disruptive models first emerged and they had to cope to the changes that were brought by them or disappear.

Now the interest in the applicability of these Internet Business Models to the mobile environment has been increasing lately. The mobile environment poses however some unique features and limitations to these models. Usage behaviors of the mobile devices are not the same as for the personal computers at home. The device capabilities are more limited, particularly the screen size is to be considered when some of these models are applied. The same business models can't be transferred successfully as such from Internet to the mobile environment and most require at least some minor changes to them.

Operators are now facing the threat of these new disruptive technologies and ways of doing business. They risk becoming plain bit-pipes in a territory they have dominated for long.

This paper investigates and studies the commonly used business models in the Internet and their applicability to the mobile environment. This paper will not state whether a certain business model is or will be successful in the mobile environment as such information depends on too many factors. However this paper will concentrate on the unique aspects and characteristics of the business models and what need to be considered and taken into accord when applying these models to the mobile environment and what are the possible impacts to existing operator business.

2. Internet Business Models

This paper will use Rappa's (2006) definition and categorization of the Internet Business Models, as he has listed in his website, to divide the vast possibilities of different business models of companies operating in the Internet to something more manageable. The list contains the following models:

- Brokerage
- Advertising
- Infomediary
- Merchant
- Manufacturer (Direct)
- Affiliate
- Community
- Subscription
- Utility

Rappa further emphasizes that the list is not exhaustive or definitive and the business models continue to evolve. Furthermore these business models are not limiting each other and a company can choose to implement several of these models and combine them however is appropriate.

There are other ways to categorize the models such as grouping them by dominant revenue model as done in a book from Afuah & Tucci (2003, ch.6). But as they state in their book, it might be more beneficial and preferable to use non-traditional combinations of profit sites, revenue models, etc for a company. Thus this paper will use the original definitions from Rappa.

2.1 Brokerage

According to Rappa's definition, Brokers are market-makers, which bring buyers and sellers together and facilitate the transactions. Usually the revenue model for brokerage companies is commission-based. The basic idea is to levy fees on transactions based on the size of the transaction (Afuah & Tucci, 2003, p.104). There are many variants within this model varying from simple transaction brokering to marketplace exchange, virtual market places and auction brokering. Commission-based business models are sustainable only by two ways. The first one is to have volumes; the second is to offset the low volumes with very expensive transactions.

One of the most famous examples in brokerage business model is eBay (eBay, 2006), which is an online auction house that makes the market for buyers and sellers. The company also provides a referral and rating system for sellers and an escrow service to facilitate the transactions (Afuah & Tucci, 2003, pp. 360-370). These additional value-added services attracted more consumers by addressing their concerns about security of the auctions.

Another more traditional brokerage company is PayPal (PayPal, 2006), which, working as a transaction broker, provides payment mechanism for buyers and sellers to settle transactions.

2.2 Advertising

Advertising is the big buzz word today especially thanks to Google (Google, 2006) and their success in the advertising market bringing their market cap to $120 billion. As stated in the special report from Elgin and Farzad (2005), there is huge potential in the online advertising market as in year 2004 the U.S. advertising spending was an estimated $300 billion to $400 billion and only $10 billion of that was spent online.

Advertising model is based on very high volumes or highly specialized viewers. With volumes, the advertisers are keener to use that channel and with specialized viewers the advertisers are surer to get their message through to their designated target market. To attract more visitors, web sites usually offer subsidized or free content, services or even products. The advertisement is made usually more efficient by customizing and personalizing it for the end users by using demographic and behavioral data.

2.3 Infomediary

Information intermediaries analyze data about consumers and their consumption habits and use it for example to target marketing campaigns. This model is closely related to advertising model and thus many authors like Afuah and Tucci (2003) have combined it to the advertisement model.

As example companies for infomediary model, one can mention DoubleClick (2006), which is a company that feeds banner advertisement to a network of web sites and collect data about web users to analyze market effectiveness. They are also involved in the advertisement business and thus combining these two models like many other companies.

2.4 Merchant

Merchant model covers the traditional wholesalers and retailers of goods and services. The goods can be sold by list prices or through auctions. Merchant model companies make their primary source of revenues via markup. The key for making profit is clearly the size of the markup and if the company has enough distribution efficiency and marketing muscle (Afuah & Tucci, 2003, pp. 108-9).

Amazon.com (2006) is undoubtedly the most famous example for a merchant company. As an another example, Apple's (2006) iTunes Music Store has also gained popularity quickly and was already the first week of its existence the biggest online music store in the world (Apple, 2003). However since making a basic web shop is very straight-forward, there is heavy competition in the merchant reselling market. Internet has also made price comparisons very easy and thus there is pressure on the size of the markup the companies can charge.

2.5 Manufacturer

Manufacturer model, or production model as Afuah and Tucci (2003, pp. 109-110) call the model, is basically a merchant model, where the manufacturer of the goods is directly selling the goods or services to customers bypassing intermediate distribution agents. The revenue model is not a markup one, but a classic value-added-in-production model, because there are usually economics of scale involved in this business model. The key behind economics of scale is fixed versus variable production costs the company has to cover in order to be profitable. With high fixed costs and low variable costs, the economics of scale will be more apparent as the fixed costs will be spread over all the units sold.

Dell (2006) is the most common example for companies using this model for their success in their direct-sales model via Internet and telephone networks. Their model allows them to shift more manufacture phases of the products to period after orders have been made and thus reduce the amount of capital needed to maintain a stock of products or components. In addition consumers can tailor their products with certain parameters enabling a mass-customization model.

2.6 Affiliate

Affiliate website network have click-through or similar mechanisms to refer customers to other sites. Volumes are not directed to a single portal, but purchase

opportunities are provided wherever potential customers are surfing (Rappa, 2006). The primary revenue source is referral-fees, which are collected by the company that steers the visitors to another company. The fee can be collected only after successful sale, regardless whether an order has been made or every time a potential lead is generated (Afuah & Tucci, 2003, pp. 110-1). Rappa further points out that the affiliate model is inherently well-suited to the web and can come in form of different variations such as banner exchange, pay-per-click and pay-per-sale. As an example company one can consider Frozen Penguin (2006) and Amazon.com (2006).

2.7 Community

Although Afuah and Tucci (2003, p. 108) include the community model under advertising based revenue model, there are vast other ways of doing revenue than just advertising with different kind of communities, which make them really interesting. Rappa (2006) puts more focus on communities in his article and raises its importance as one of the more fertile areas of development, especially in the social networking area.

The viability of a community based business model according to Rappa is based on user loyalty. Users have high investment in time, emotion and mind-set in communities. Revenues can be collected through services, voluntary contributions, sale of ancillary products or services, or using other business models such as advertising and subscriptions.

Red Hat (2006) and Wikipedia (2006) among other companies can be seen as examples for this model. If you stretch the definition enough, all online communication that creates communities can be fit into this category as well. Communication technologies in general are based on different size of communities and their basic needs to communicate within the community and between communities. Skype (2006) can be considered as a prime example on this area. Communities such as Skype will benefit from the effects of network externalities greatly.

2.8 Subscription

In subscription model customers are charged on a periodic basis a flat-fee for access to certain services or products. Companies use subscriptions usually to offer "premium" service or content in addition to free service or content. The fee is charged regardless whether the customer actually uses the service or not. According to Afuah and Tucci (2003, p. 111) the subscription model does not appear to be feasible for most content businesses due to competitive pressures and it has been feasible only in segments with little competition.

However one can argue that on certain areas, the subscription model is more successful than for example the utility model. Customers are more willing to accept monthly fees for unlimited use for ISP services than get charged for every bit and byte they transfer. The model is clearer and the customer is more aware how much the service actually costs to him than with the utility model. Heavy users, who adopt new services usually first and act as referrals to other customers, pay less proportionally in the subscription model compared to the actual usage and tend to prefer subscription based approach.
Other companies than ISPs with subscription model include many online newspapers, person-to-person networking services and content services such as Pandora (2006).

2.9 Utility

The utility or "on-demand" model as Rappa (2006) states is based on metering usage. The primary revenue model is a fee-for-service model (Afuah & Tucci, 2003, pp. 111-2), where users only pay for the services they actually consume. There are some ISPs that base their model on utility rather than subscription model, but more movement from utility to subscription model can be seen in the history of the ISP industry.

The utility model suffers in addition to potential confusion among customers on the fact that it is only sustainable business, when there is actual usage of the service. If the usage suddenly drops, there is no safety-net like in subscriptions, where the company has a certain subscription base to leverage. Also the billing costs are usually more than in traditional subscriptions as there is need to meter the usage and further analyze and process that data for invoicing.

3. Mobile Environment

Mobile environment has many similarities to Internet, but it has also some great differences in characteristics, features and usage behavior. The mobile phones are evolving to mobile personal computers, digital cameras and music players. Already the mobile phone vendors are largest digital camera vendors in the market and the same can be said soon about music players if not already.

The most differencing factor compared to traditional Internet is obviously the mobility. The devices are usually carried along to every place the consumer visits. There are already existing customer relationships between operators or ISPs and consumers, which can be evolved in some cases to handle even micro-payments for services and content. There are even plans to replace cash by incorporating RFID payments to mobile phones (O'Connor, 2005). So the mobile environment has also a location attribute, which can be used as basis for a business model.

The devices have limitations such as screen size and humanly readable resolution, the amount of input keys is limited and there are alternative user input methods such as touch screens, pens, etc. The processing power and battery life is also limiting applications as the device must retain its usability for other purposes such as communication. The network access speeds are not at

the same level as best broadband connections on fixed-line networks, but they are evolving all the time enabling new possibilities all the time.

Usage behavior of mobile environment differs greatly from the normal Internet usage; mostly because of the limitations of the device capabilities and size, but also because they are used more with multiple senses and not necessarily at the same time. For example, customers do not tend to look at the screen when they are speaking to the phone. There are exceptions of course such as video calls, but they have not gained yet much popularity. With increasing device capabilities, some of the gaps between Internet usage and Mobile Internet usage are closing, but the compactness and different user interfaces are still going to affect the usage patterns.

In a press release from Ipsos (2006) of a new study The Face of the Web about mobile phone internet usage, they state that the Internet access via mobile phones is becoming a mainstream activity and poised to become a dominant way of accessing the Internet outside the home. Furthermore there is a strong relationship between Internet usage and mobile phone ownership according to the study opening opportunities for services or applications that can link aspects of personalization across multiple Internet platforms.

As a further conclusion can be drawn that combining the traditional and mobile Internet usage in a single service, while keeping in mind the different characteristics, can be potentially a very successful formula.

4. Applicability

4.1 Brokerage

Existing Internet Brokerage models, such as auctioning, can be applied to mobile environment through normal browser usage. However it should be noted that due to limitations of wireless connection speed and the devices, the consumers might give up using the service very fast if they can't find something that attracts their interest soon. Easy searching feature and short category structures are recommended.

In addition to normal browser behavior, mobile devices can be applied to new kind of models, as in transaction brokering to RFID payments (O'Connor, 2005) and operator billing through premium SMS or direct billing services. Existing browser-based services can be enhanced also with alerts for example in auction services when a customer has been over bidden.

Existing applications include stock market applications where speed of decisions and information in addition to alerts are essential. All in all, the mobile environment offers great opportunities for brokerage model, if the necessary information can be delivered in a compact format.

Another example of existing brokering business in mobile devices is Nokia's (2006) Preminet Solution, which is focused on mobile content and service discovery, purchase and consumption technologies.

Operators are natural part of existing transaction brokering services in mobile environment, but there are new entrants to the market such as PayPal. The operators can only offer coverage of their subscribers, but their strength is the ease of use for the end customers. Other entrants include credit card companies, which are very keen especially on the RFID technology, which will likely be very disruptive to existing operator premium SMS business in countries with high credit card penetration, once the technology is more adopted.

4.2 Advertising

As the advertisement is the buzz word nowadays and all the big players eye on the mobile advertisement cake eagerly, there is lots of development in this area. SMS advertisement was one of the first ways of advertising in a mobile device. It is still applied nowadays, however there are more regulations in place that prevent unwanted messages to be sent to end customers. Other ways used today include for example advertisements injected into applications and games.

Mobile browser based advertisement is of course the easiest approach for most vendors to the advertisement space in the mobile device and largely dominated by the current Internet advertisement companies. However, the real development and competition at the moment is focused on applications and the common user interface of the mobile device. The real-estate on the mobile screen is very valuable for advertising although it is limited and people do not tend to view it actively. Correct placement in certain key functions can be very fruitful.

There has been and still is lot of competition between operators and device vendors about who controls the user interface, but now the big players from the Internet are entering the game as well. Yahoo (2006) and Google (2006) among others have their own mobile applications, which they are now pushing hard to the devices. Will the new entrants dominate the user interface of all mobile devices in future, or will device vendors and operators retain some of the control still, is to be seen in the next few years.

While operators have a good position at the moment, they are not able to utilize the full potential of advertising model as few have high enough volumes or highly specialized customer groups compared to other competitors for the advertising business.

4.3 Infomediary

Infomediary model basically should work the same as in traditional Internet with the limitations of mobile browsing. However the applicability of this model is

greatly depending on the service from which the data is collected as the user attention span in mobile browsing is not that great. The model could be applied to other methods of using mobile devices than browsing, but most probably this model should only be applied in addition to some other business model or already existing business in the traditional Internet.

However there are applications that monitor the customer's mobile usage behavior, etc, which might be considered to fall into this category. Convincing the end customer to enable these applications widely needs however some kind of carrot and/or other useful service for them.

4.4 Merchant

Mobile content and service sales at the moment rely pretty much on the conventional media advertising and discovery. Almost all of the retailers use the Internet to further promote their sales, but the actual purchase and payment of the content is usually done with a mobile device. The usual mobile browsing restrictions apply to merchant model as well, but the billing methods for low-value content available usually for mobile devices compensate them.

Jamba (2006), which is known is some countries as Jamster, is a typical example of a merchant that sells mobile content such as ringing tones, wallpapers, video tones, etc. They act as aggregator and make their own content as well using characters such as Crazy Frog to further make their image and brand more known. They use conventional media such as TV and newspapers to advertise their content.

Most operators have been selling content to their subscribers and filling the mass market's demands, but managing the content business, acquiring new content deals, etc. can be very resource demanding work. Many of the operators have since adopted a brokering model where they offer a market place for companies and aggregators to sell their content.

4.5 Manufacturer

As software vendors that are selling their own software fall into this category, there is some usage of this model in the mobile environment. For hardware products currently there are not many, if any, companies acting in the mobile environment. Mobile devices are products that have a style element and strong association to brands in them and as such it is very hard to sell them to mass-markets from the Internet. Technology enthusiasts are keener to purchase mobile devices through browsing as the style and design elements are not that important to them.

Accessories are much easier sell on the web, but so far not many vendors are using other access methods than browsing to sell their content. There are some vendors, such as game developers, who sell activation codes for example extra levels from their game to customers. Some DRM technologies, such as developed by OpenBit (2006), allow super distribution of games and applications and provide purchasing of relevant rights to the content from the application itself. It can be argued that this model is more of a merchant model as OpenBit acts here as a retailer. They are selling their own software though through their technology as well.

4.6 Affiliate

Affiliate model can be applied in the normal mobile browsers as in the normal Internet, but the real question is, can it be applied beyond the mobile browsing? The answer is yes, as for example in-application or in-game advertisement can be used with the affiliate model to generate additional revenues.

4.7 Community

Communities and communication business are closely related and as such community model has many applications in the mobile environment. Normal voice communication with mobile phones is prime example of technology that addresses the needs of communities. However, the current voice technologies and standards focus only on the transfer and not the community aspects around it. These features have not yet evolved to the level that can be seen for example in the Internet with instant messenger applications.

Instant messenger applications such as provided by Yahoo (2006), Microsoft (2006) and Skype (2006) are entering the mobile market and threatening the traditional voice communication offered by the operators. The new entrants offer more advanced features such as an ability to know before calling, if the person is available for contact and not for example in a meeting.

Operators should take communities seriously as it is their core business, which is communication. However, the network externalities effect causes that the compatibility between different operators must be reserved and proprietary incompatible technologies will face sooner or later extinction. Instant messenger companies will try to get their place on the UI through their applications and use other business models such as advertising to get their revenues. This will pose a problem to operators as they will lose the UI, if they will charge something for use of service. Alternative business models should be explored.

4.8 Subscription and Utility

Subscriptions are very common part of the mobile environment, as almost everyone has a subscription for mobile usage such as data and voice. The subscription and utility models tend to blur a bit here as there usually is a limited amount of service available for a fixed cost and additional service is covered by a utility model. All kinds of subscription packages are offered nowadays

ranging from x amount of short messages to unlimited data in a month and other additional premium services.

Beyond operator offered subscriptions, for example Jamba (2006) uses subscription model a lot in their business. Other users of subscription model include various news services that provide general daily news or more focused ones, for example a news service that is centered on an event such as the World Cup 2006 in football. The services can be fixed price subscriptions or based on actual usage.

Usually companies tend to favor more the fixed price subscriptions as it provides them a steady income; however the competition might opt to use the utility model, where it might become more cost effective for the common customer. It is still though more confusing approach, especially if it's hard for the customer to estimate how much he will actually use the service in future.

3. Conclusion

Internet business models can be applied to mobile environment although they tend to focus primarily to the Web. The unique characteristics of mobile environment should be taken into consideration and mobile browsing is not 100% equivalent to normal Internet browsing with a personal computer. Mobile devices have multiple usage purposes and are limited in many ways such as size, battery and input methods.

The mobile environment however offers new possibilities for creating new business models with for example the location attribute. Browsing is just one of the ways of using a mobile device, and there are multiple various applications that could be explored when looking for options for making business.

Existing billing interfaces are clearly an advantage, although the market with premium short messages is fragmented, because each operator and country has their own regulations and methods. This will likely be disrupted when credit card companies and device vendors introduce new technologies.

Device vendors and major operators have a clear edge in mobile environment as there is great advantage of having the application or service already embedded in the mobile device, when the customer buys the device. The mass-market requires an easy access to the service or product to be effective.

However the big players from Internet world such as Yahoo and Google are challenging all this and can most likely provide more innovative ways of doing business as most operators tend to be more focused on keeping their business than developing new business models. The disruptive models can't be countered or adopted by all operators and some of the operators without high volumes will most likely change their strategies sooner or later to perform well in the bit-pipe business

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