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Topical Evolution Paths of Mobile Multimedia Services

Proceedings of the Research Seminar on Telecommunications Business

Editor Sakari Luukkainen

TEKNILLINEN KORKEAKOULU
TEKNISKA HÖGSKOLAN
HELSINKI UNIVERSITY OF TECHNOLOGY
TECHNISCHE UNIVERSITÄT HELSINKI
UNIVERSITE DE TECHNOLOGIE D'HELSINKI

Helsinki University of Technology
Telecommunications Software and Multimedia Laboratory
P.O. Box 5400
FIN-02015 HUT
Tel. +358-9-451 2870
Fax. +358-9-451 5253

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MOBILE MARKET IN FINLAND

Mathias Tallberg
Helsinki University of Technology, Networking Laboratory
P.O. Box 3000, FIN-02015 TKK, FINLAND
mathias.tallberg@tkk.fi

Abstract

Much has happened during the last five years on the Finnish mobile communications market. Recent developments include: the introduction of mobile number portability (MNP) in July 2004, the emergence of mobile virtual network operators (MVNOs), price war and hyper-competition followed by consolidation, late deployment of 3G networks, however, with early upgrade to high-speed downlink packet access (HSDPA), and the allowing of 3G handset bundling.

The objective of this paper is to study the current state of the Finnish mobile market. This has been done with a mobile operator centric view. Based on a literature study and continuous monitoring of the Finnish market, this paper depicts the current situation on the Finnish mobile market and tries to explain the reasons behind this development due to the changes during the last few years. This paper starts by giving a general description, or introduction, of the current situation on the Finnish mobile market. Then, the influence that the recent price competition has had on the innovativeness of Finnish mobile operators is analyzed shortly, followed by a short analysis also on the influence of consolidation on price competition. This is then followed by a more extensive analysis on the allowing of handset bundling for 3G terminals in Finland, starting from April 2006, and how it has changed the situation for mobile operators in: increasing customer loyalty, raising average revenue per user (ARPU), in service differentiation, and in investment of new services and infrastructure. This paper also attempts to provide some empirical data on what has happened before and after allowing of 3G handset bundling in Finland. In the end the conclusions are drawn.

Key Words
Mobile market, mobile operator, price competition, handset bundling, Finland

1. Introduction

The nature of the mobile communications market is seeing remarkable and rapid change. The convergence of telecommunication and data communications, both in networks, services and devices, and the evolution towards a mobile all-IP infrastructure, is pushing the well known Internet services, content and applications also to the mobile networks and handsets. The mobile networks are evolving towards higher data speeds and capacities, and lower latencies. Also an evolution towards reasonably priced connections that can help in facilitating the adoption of a whole new portfolio of new mobile services and content is visible. The regulatory environment is changing as well. Deregulation of telecommunications in general has been a trend in telecommunications already for several years. New business models have emerged, and will emerge also in the future, and are putting pressure on the traditional mobile operators. For example, due to favorable regulation in some countries, new entrants can easily start competing with traditional mobile operators, as MVNOs. There is a global interest in increasing competition throughout the telecommunications, as well as the data communications industry. As a result of increased competition, mobile operators' ARPUs have been declining. However, the introduction and adoption of new mobile services, applications and content is hoped to set off this decline in the near future.

Finland has been, without argue, a forerunner when it comes to mobile communications. However, the times have changed and Finland is today lagging behind in mobile communications and it is not considered to be the benchmark country regarding future mobile services anymore. There are many reasons behind this observation. Deregulation and liberalization has been a growing trend and this has had a huge impact on the Finnish market. Following this trend, the Finnish mobile market has seen many developments, for both good and for worse. Many of these developments have increased competition, others again not. The increased competition has brought developments along that have led to a stagnation of innovation and investments for future research and development. Much of this has happened during the last five years or so. These developments include the introduction of MNP in July 2004, emergence o MVNOs, price war and hyper-competition followed by consolidation, late deployment of 3G networks, however, with early upgrades to HSDPA technology, and the allowing of 3G handset bundling.

The mobile communications market has developed into a market that is significantly different from what it was a few years back. After the introduction of mobile packet-based data services (2,5G and beyond), the situation for the mobile operators has changed radically. Circuit-switched voice services and SMS messaging is not the only source of revenue anymore. Mobile operators need to be able to take full advantage of the opportunities related to these services, many of which are disruptive in nature, and innovation has become a key for success. It seems that the mobile operators have to be extremely competitive and, above all, innovative, to survive.

It has also become very difficult to predict what will happen in the future on the mobile market. Possible reasons are e.g.:

1. Deregulation of telecommunications in general;
2. Technology evolution;
3. Convergence of networks, services and devices;
4. New services that are disruptive by nature;
5. Emergence of new and innovative business models.

The business that mobile operator are part of today is about big investments and fierce competition. There are many issues a mobile operator needs to consider when making decisions that will affect its future, including regulatory issues as already mentioned, investment issues, marketing and pricing issues, and competition related issues. The environment that mobile operator live in today is changing rapidly and hence creates challenges that really need to be taken into consideration.

The mobile data and mobile Internet service diffusion have shown to be a complex process that contains remarkable market uncertainty as described by Gaynor (2003). Currently mobile data services, excluding the SMS service, consist only of a few percents of the mobile operators' revenues. Also, open Internet services have started to disrupt the operators' walled garden approaches and threatening to leave them as bit pipes only.

Currently we are amidst a transformation to new sophisticated and high-performance handsets, and enhanced mobile and all-IP data networks. New service and application innovations are emerging constantly. Handsets that facilitate imaging, mobile browsing, email, instant messaging, personal information management, streaming multimedia, music player capabilities, and the use of various 3rd party applications are today becoming more and more common. Hence, there is a lot of potential for new mobile services. This, together with the ubiquitous nature of mobile computing, drives also business interest into new services and applications.

Developments in the performance of mobile handsets have been one element in driving the mobile communications market towards the mobile Internet. The functionality, including the growing memory and processing power of today's mobile handsets are, more and more, resembling the functionality of personal computers, which makes it easier for the end-users to understand what the mobile Internet actually is about. As long as the mobile Internet is marketed as something totally different than the actual Internet, people will have difficulties in realizing the advantages that the mobile Internet can give to peoples' lifestyles.

Some of these new mobile services and applications can be regarded as disruptive by nature, because of them being possible threats, however, opportunities as well, to the traditional mobile operator's current service portfolios. Together with alternative radio interfaces, such as Bluetooth, WLAN, WiMAX and DVB-H, these new services may seem to be threats, or at least alternatives, to some of the current services. However, by correctly leveraging on the new opportunities, the traditional mobile operators may also benefit from these new service innovations.

2. The Finnish Mobile Market

The Finnish mobile communications market, along with the markets of the other Nordic countries, has been a forerunner as far as mobile communications is concerned. Finland was a global leader in the mobile communications business during the growth of voice services. The success of many players in mobile communications was possible because of this leadership. This is unfortunately not true anymore. After the introduction of packet based mobile data services (2,5G and beyond), the situation has changed significantly. Other markets, especially the Japanese and the South Korean markets are now gained the leading positions. Even from the Western European point of view, Finland can no longer be considered as a leader or forerunner.

Until recently the GSM business has been quite profitable in Finland, however, this has changed during the last five years or so. Hence, the success of mobile data services business has become a critical success factor for the Finnish mobile operators because of declining ARPUs. In 2003 the MNP arrangement was introduced by the Finnish regulator in order to make it easy for the subscribers to change their mobile operator. The authorities also intervened by requiring and guaranteeing equal network usage fees for possible new entrants in form of MVNOs. Instead of innovation driven growth this deregulation of the Finnish market has led to exceptional price competition, or price war, which has commoditized the basic mobile voice and SMS services. This fast price decline has slowed the innovation process on the Finnish mobile market by requiring increasing cost reductions after cost reductions.

The coverage of the Finnish 3G networks is still restricted to the urban areas only, and the penetration of 3G enabled handsets has been growing slowly. However, after the allowing of 3G handset bundling clear indications of growth in 3G handset penetration is visible. Another thing that has helped in the growth of 3G handset penetration is the actual availability of more and more 3G capable handsets, which has also led to declining 3G handset prices. Because GSM networks will still be able to serve a large proportion of the demand for the basic mobile voice service in a cost efficient manner for many years to come, the only way for 3G to be able to differentiate may be trough mobile data services. However, there can still be some latent communication needs of end users, which can be served by new technologies. One of the key issues in succeeding is to go back to the growth track driven by innovation and to make the market demand and technical opportunities meet.

Now that the mobile voice and SMS market has entered into a mature phase, which has been characterized by intensive price competition and high customer churn due to lighter regulation, service differentiation has become critical. Recent consolidation and the allowing of 3G handset bundling has however, decreased the heavy price competition. The mobile operators are now developing new marketing and pricing schemes to increase customer loyalty, both in form of for example flat-rate based mobile data and 3G packages. The market players have been forced to knowledge that it can be cheaper to keep an existing customer than to acquire a new one.

Despite the small size of the Finnish market, there are many companies in Finland that offer mobile subscriptions. Traditionally mobile subscriptions have been offered by mobile operators that have owned their own network, the so called mobile network operators (MNO). However, during the past few years, and due to deregulation, an increasing amount of companies are offering mobile services as mobile service operators (MSO) or MVNOs (see e.g. Smura & Marjaniemi 2005, Kiiski 2006 and Kiiski & Hämmäinen 2004). In this study we will only consider the actual MNOs and leave the MSOs outside of the scope of this paper.

The MNOs in Finland are Elisa, Sonera and DNA Finland. These players have licenses for both GSM and 3G networks. Each of them has a separate subsidiary that takes care of the network operator business, while the MSO business is being taken care of by another business unit or subsidiary (Vesa 2005). The market shares of these MNOs can be seen in Figure 1 (Ficora 2007).

Table 1: Market Shares of Finnish MNOs (Ficora 2007)

MNO	Sonera	Elisa	DNA
Market Share	43%	38% *	17%

* Including customers of Saunalahti

According to market research done by Ficora (2007) approximately 100 000 bundled 3G-subscriptions was sold in Finland between October 2006 and December 2006 (Q4). These accounted for approximately 32% of all "new" subscriptions during this period. The Finnish market has also seen growth in service usage compared to the same time period in 2005, for example, the Finnish market has seen growth in:

- mobile voice usage by 23%;
- SMS usage by 22%;
- MMS usage by 35%;
- mobile data traffic by nearly 300%.

3. The Influence of Price Competition

One of the most important factors influencing the competitive landscape on the Finnish mobile communications market was the introduction of MNP in July 2004. A total of over 3 million mobile numbers have been ported during the period between July 2004 and the end of 2006 (Numpac 2007). Recently, there has however been a decline in the amount of ported numbers. This started already before the start of 3G handset bundling in 2006, so for example the market consolidation had an impact already before April 2006.

The numbers mentioned above indicate that there has been intense competition on market shares, both in form of new subscribers, but in form of existing subscribers as well. This then led to market consolidation in form of the acquisition of Saunalahti by Elisa, but also to market exits (Tele2 and ACN Finland). The excessive price war had a huge impact on the profitability of all Finnish mobile operators.

Finland was the 35th country in the world to open commercial 3G operations when Sonera opened its 3G network for commercial use (Q3/2004). Elisa followed soon after by opening their network as the second mobile operator in Finland (Q4/2004). DNA followed by introducing 3G late in year 2005. Elisa was the first Nordic mobile operator to upgrade its 3G network to HSDPA (Q2/2006). DNA followed with its upgrade in the first quarter of 2007. Sonera has not updated its 3G network to support HSDPA yet, however, it will during the incoming months.(Elisa, Sonera & DNA Finland)

4. Impacts of 3G Handset Bundling

This chapter will give a more extensive analysis on what has happened on the Finnish mobile market by analyzing the impacts of allowing of 3G handset bundling that started in April 2006, and how it has changed the situation for mobile operators to increase customer loyalty by reducing churn, to raise ARPU by increased usage of new mobile data services, to differentiate by offering new 3G handset-subscription packages, and to invest more in new services and infrastructure (e.g. in HSDPA). This chapter will look more closely into the impacts of handset bundling of 3G handsets, and especially in its ability to drive the usage of mobile data services.

The details of the 3G handset bundling ruling in Finland include a maximum contract period of 24 months, zero-cost SIM-lock removal after the subscription contract period, and the request for offering the same services also outside of the bundled 3G handset-subscription packages. This new ruling will be as is for a 3-year period.

The promotion of the adoption of new mobile data services has emerged as a possible argument for 3G handset bundling in Finland. Handset bundling, however, has complex implications not only on data service adoption, but also on the mobile market dynamics more broadly. Due to the complexity, regulators have difficulties in anticipating the impacts of handset bundling. A framework that enables the identification of related regulatory control points, and their qualitative impacts, will be presented. The framework is based on research by Tallberg et al. (2006). The results of this framework are based on observations before and after the change of 3G handset bundling law on the Finnish market.

According to Eppen et al. (1991) the potential benefits of bundling include cost savings in production and transaction costs, complementarities among the bundle components, and sorting consumers according to their valuations. Jameson (2005) summarises industry opinion as follows: “the strategic goal of service providers with the deployment of bundled services is to acquire new customers, charge their current customers more, and keep the customers they already have.” The strategic use of bundling has also been analysed by e.g. Whinston (1990), Carbajo et. al. (1990), and Chen (1997).

The framework mentioned above can be seen in Figure 1. The framework shows the impacts of handset bundling on the usage of data services in the rapid transition from no-bundling to handset bundling for 3G handsets in Finland. Note that the framework ignores the other non-usage consequences of handset bundling as well as the other non-bundling factors affecting service usage.

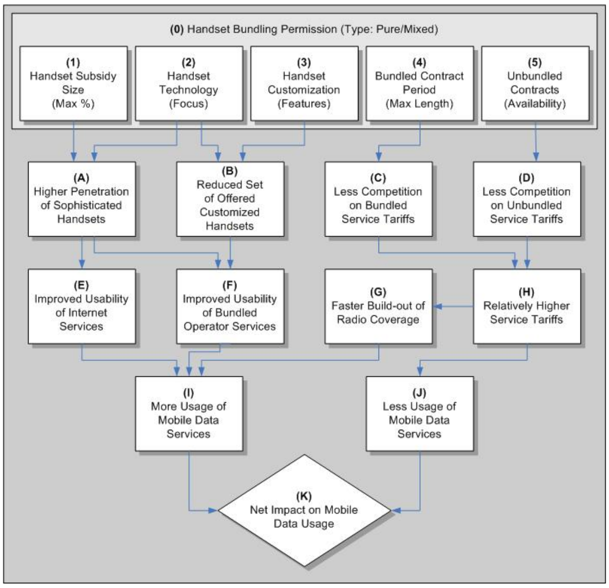

Figure 2: Handset Bundling Framework on Impacts of Mobile Data Usage (Tallberg et al. 2006).

What has happened in Finland after the introduction of 3G handset bundling? This will be studied further next. The main impacts that can be considered to have followed out of 3G handset bundling are shown in Table 2.

Table 2: April 2006, Before and After. (COIN project, Operators, Ficora, Numpac & Kivi 2006)

April 2006	Before (Jan 06)	After (Jan 07)
Handset bundling	Not allowed	Allowed - Targeted
Competition	Heavily on price	Services and 3G-packages
Mobile handset base	~0,5% 3G	~10% 3G
Marketing of mobile data	No	Still No
Usage of mobile data	X MB	(3-4)*X MB
Customer churn	>15%	<15%
Switching cost	Low	Higher

We can today see an improved base of sophisticated handsets in Finland, especially handsets with 3G capability. The penetration of 3G capable handsets or terminals was approximately 0,5% in August 2005 (Kivi 2006). The penetration of 3G capable in September 2006 had increased to approximately 10% (COIN project). There is also a declined focus on price competition on regular voice and SMS services in Finland, both for bundled and unbundled subscriptions. However, the marketing efforts on mobile data have not grown rapidly after the allowing of 3G handset bundling. However, the focus today is more on 3G handset-subscription packages.

Usage of mobile data has seen a significant increase (COIN project & Ficora 2007). Reasons for this can be the increased amount of 3G capable handsets, but probably also an increased amount of sophisticated non-3G handset penetration as well. Other factors might be an interest towards mobile data in general. This has also brought with it a faster pace, at least subjectively, in the build out of 3G networks both in terms of coverage and capacity and for 3G network upgrades in form of HSDPA.

Because of the decline in competition, we can also see a clear indication of declining churn numbers. This is not only because of the introduction of 3G handset bundling. It was already clearly visible before that (Numpac 2007). However, 3G handset bundling will have a declining effect on future churn numbers because of the higher switching costs related to handset bundling. There might of course be other reasons that might drive the churn numbers up again in the future.

Table 2 indicates that a regulator can use this form of targeted handset bundling (3G) to speed up adoption of new services. However, this form of bundling may cause higher monitoring costs for the regulator than before. Also, it is not certain if such positive impacts that have been seen in Finland so far will be durable or easy to achieve in the future. And it also needs to be remembered that bundling do not only offer positive impacts, there might be some negative impacts as well, one already indirectly mentioned might be a lower level of rivalry among competitors, due to for example higher switching costs. However, the negative impacts can be reduced by for example shortening the maximum contract period.

From the subscriber viewpoint, 3G handset bundling will likely improve the user experience, at least until 3G capability in handsets becomes commonplace. It also needs to be remembered that according to Tallberg et al. (2006), the distinctive parameters of every mobile market may affect the actual impacts of handset bundling in many ways, both qualitatively and quantitatively. For example, pre-paid driven markets are less influenced by handset bundling than its post-paid driven counterparts.

9. Conclusions

The domestic telecommunications market is no more a clear forerunner in the international context. Instead of innovation driven growth, the market is characterized by intensive price competition. The competition in the Finnish mobile operator business has been fierce during the recent years. This has had a dramatic impact on future investments in both mobile services and infrastructure and services. Finland has not been able to take full advantage of the opportunities related to mobile data and mobile Internet.

The Finnish mobile operators need to drive the mobile communications market by anticipating their subscribers' lifestyle changes, which means that the mobile operators need to be able to offer rich end user experiences to make the most of the technology that is offered today, but also of the technology that will be offered tomorrow. Further, by improving usability and lowering the barriers for "trying and buying" of new mobile services and content, mobile operators need to be able to deliver on the promise of bringing the mobile lifestyle also to the mass market, not only to the early adopters or innovators. 3G handset bundling may serve as a good medicine to do just that. As we have seen in chapter 4, targeted handset bundling, for 3G as in the Finnish case, and if carefully tuned by regulator, can have a positive impact on the adoption of new services in the context of fast technology evolution.

The future business drivers for mobile operators can simply be divided into making money or saving money. To make money, mobile operators need to sell more, i.e. get their existing subscribers to use more of the services that are offered, which needs to be done through a more efficient or rewarding process. The other way to make money would be to get new subscribers into adopting new ARPU increasing, and alternatively churn decreasing, mobile services. If a mobile operator is not able to do so, with the already decreasing ARPUs, the only way out may be to build a very thin and especially effective organization and save money. A mobile operator can be able to save money by reducing e.g. customer service and support costs, becoming more efficient, and by keeping the existing subscribers happy.

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MOBILE BROADCAST

Olli Loikkanen
Helsinki University of Technology

Abstract

This paper compares three different formats, namely DVB-H, DMB and MediaFLO, that can be utilized for delivering mobile television(TV). These formats define the architecture for digital video broadcasting. Services can be build on top of the architecture. This paper also discusses three different service types that can be provided through the broadcasting channel. These service types allow different business models for operators and vendors. The operator models are based on distributing content for the customers and the vendor models are about offering equipment to customers. In the operator models the revenues come from commercials, access to content or from the network utilization. All of the technologies described in this paper are relatively new and have been available for the public from less than two years. The competition between these three different standards is intensive. In most countries they are still in a trial phase or not available at all. Even though the trials have been successful it is still too early to tell if the new technologies will be widely adopted. Much of the success of mobile TV depends on the available content and it's price for the users.

Key Words

MobileTV, DVB-H, MediaFLO, T-DMB, broadcast operator business

1. Introduction

Digital video broadcasting is replacing analog broadcasts and becoming the standard for delivering video content to end users. Digital television is already widely available in Finland and it is taking the place of analog television. Technology has evolved and mobile devices and networks are ready for digital video. Now it just needs to be adopted by the users. Users will only adopt it if the content and services are of real value to the users. This is a challenge for the operators, vendors and content providers.

There are several different standards for delivering mobile TV to hand held devices. This paper concentrates on mobile TV and specific on the services that utilize DVB-H(Digital Video Broadcasting Handheld). This paper discusses and compares DVB-H with two competing standards that are currently available. These standards are DMB(Digital Multimedia Broadcasting) and MediaFLO, the first one was developed in South Korea and the latter one in USA. Differences between DVB-H and DVB-T(Digital Video Broadcasting Terrestrial) are covered as well.

This paper studies the opportunities DVB-H gives for hand held device manufacturers, service providers and content providers. Mobile TV impacts operator business and gives it a whole new way of making profit. Content providers will reach more users and can deploy new services, such as traditional TV games, through mobile TV. The current status of DVB-H and services utilizing it is discussed. The paper also covers the major problems that need to be solved before mobile TV really breaks through.

In this paper we present various available technologies that can be utilized when providing mobile TV for hand held devices. We discuss the business opportunities that mobile TV creates on the operator and vendor market. The structure of the paper is as follows. Chapter 2 describes the DVB-H standard and compares it with DVB-T and other competing standards. Then Chapter 3 discusses different service types can be provided on top of mobile TV architectures. After that chapter 4 describes the impact of mobile TV on operator business. Then chapter 5 explains the current status of available mobile TV services for customers. Finally chapter 6 provides conclusions based on the conducted study.

2. Mobile Broadcast

Various different architectures that enable mobile TV exist. Basically there are two ways of delivering mobile TV to hand held devices. The first one is by utilizing two-way cellular networks using unicast transfers. The second one is through a one-way broadcast network. This chapter concentrates on the architectures of the latter one. Specifically on DVB-H and it's competitors T-DMB and MediaFLO. This gives only an overview of the different standards and does not go into much technical detail how the stream is compressed and how the actual transmission are modulated.

2.1 DVB-T and DVB-H

DVB-T is a digital video broadcasting standard for terrestrial television. It replaces analogous television and uses the same 6Mhz, 7Mhz and 8Mhz radio channels that are used by analog television. DVB-T first compresses the audio and video stream utilizing the MPEG-2 codec and then transmits the compressed stream. DVB-T defines two different transmission modes that are “2k mode” and “8k mode”. Both of them can be used as single transmitter or they can be used in

Single Frequency Networks (SFN). The first one is used when the distance between the transmitters of the SFN is limited and the latter one can be used in large SFN networks. DVB-T combines from 3 up to 6 programs in to one multiplex that it sends in one 8Mhz analog channel.

DVB-T was designed for fixed receivers where power consumption is not a problem. DVB-H is a standard for mobile receivers, such as cell phones or PDAs, and it is derived from DVB-T. The mobile receivers are usually hand held and light devices that are battery powered. To make the battery last longer DVB-H allows the devices to power off some parts of the receiver during reception. DVB-H uses time-slicing and this leads to bursty sends of the video stream which allows the power saving.

Other issues with mobile terminals are man made noise and the mobility of the terminals. DVB-H introduces an additional 4k transmission mode and a MPE-FEC (multiprotocol encapsulation forward error correction) scheme to overcome these problems. These reduce both, the data rate of the service and the possible coverage of the network. “4k mode” uses IP datacast for delivering content. The “4k” mode offers a trade off between cell size and user mobility. It introduces a new channel of 5Mhz which is the width of the radio channel in UMTS as well. (ETSI EN 300 744 V1.5.1 2004)

2.2 DMB

DMB is another standard for delivering multimedia content to mobile devices. It was developed in South Korea and it is a competing standard for DVB-H. DMB transmissions can be sent employing S-DMB(satellite Digital Media Broadcasting) for outdoor coverage and T-DMB(terrestrial Digital Media Broadcasting) for urban area and indoor coverage. DMB utilizes H.264 codec for video compression and BSAC or V2 for audio compression. The compressed audio and video is then transmitted in an MPEG2 stream as in DVB-H. This paper concentrates on the T-DMB standard which is based on the DAB(Digital Audio Broadcasting) standard. Therefore T-DMB devices can also receive DAB audio and data signals. This allows the implementation of data services such as stock exchange or weather information. The bandwidth of a channel in DAB and also in T-DMB is 1.7Mhz.

To overcome the problems mobility introduced, T-DMB uses Forward Error Correction(FEC) like DVB-T. Time-slicing is used to achieve bursty transmissions and this will enable power saving at the receiver. (ETSI TS 102 427 V1.1.1 2005, ETSI TS 102 428 V1.1.1 2005)

2.3 MediaFLO

MediaFLO is the third standard for broadcasting content to mobile devices that this paper covers. The content can include audio streams, video streams and data. MediaFLO is develop in United States and is a competitor to T-DMB and DVB-H. MediaFLO uses Forward Link Only(FLO) transmitters to deliver the content to the devices. The data to the FLOs can be sent via satellites, fiber or any other technology available for data transfer. Because FLO transmitters are used, the channel is one way only. To implement services that need customer interaction, such as video on demand, a 3G networks, for example UMTS, has to be used as the return channel. In addition to providing control functions the network 3G is used for user authorization.

MediaFLO utilizes H.264 for video compression. On the physical layer FLO transmitters use the same “4k mode” as DVB-H. Supported bandwidth frequencies, that are 5Mhz, 6Mhz, 7Mhz and 8Mhz are also the same as in DVB-H. Different data rates are available and they can be used as a trade-off between area coverage and throughput. FLO can also support both, local area and wide area content in a single Radio Frequency carrier. (Qualcomm)

2.4 Comparison of the Standards

All the standards presented in chapter 2 are standards that can be used when implementing a digital video broadcasting system for mobile devices. There are differences between the standards but all of them have the same goal and therefore they also share some characteristics. Those include the ability to save battery power by using bursty data transmissions and error coding of the transmitted data.

All of the standards utilize Orthogonal Frequency-Division Multiplexing (OFDM). DMB and DVB-H utilize convontianal coding where MediaFLO utilizes turbo coding. The competition between the standards is so intense that available measurements of number of channels offered and batttery lifetime between different standards highly depend on the conductor of the study. It can be clearly seen that studies conducted or sponsored by Qualcomm state that MediaFLO is superior to it's competitors. On the other hand studies released by the DVB-H community support the fact that DVB-H outperforms competing standards. (Qualcomm)

From the users' point of view the differences are really small and they do not affect the user experience substantially. Right now it seems that the different comparisons and performance tests are just marketing means to get hardware manufacturers behind a standard. Also the technologies are still mostly in trial and test phases and waiting to be widely adopted.

Each of the standards requires an infrastructure for delivering the data to the users. This includes transmitters, transmission towers and an underlying core network for delivering the actual data to the transmitters. All of the standards can use any existing core network and transmission towers that are available. However each standard requires the installation of their own transmitters. Therefore the existence of any other broadcasting architecture in an area does not give any competence to any of the three mobile broadcasting standards.

3. End-user Service Types

Three different service types can be offered on top of a broadcast architecture. Two of those services require a return channel that is either provided by the broadcast infrastructure or by a separate network. The service types are categorized based on their interactivity level.

The service type, namely local interactivity, can be achieved with the lowest level of interaction, that is interactivity between the user and the terminal. No return channel to the actual sender is required. One example of this type of service is broadcast TV. When the return channel only carries a user response the service type is called one-way interactivity. An example of such service is voting. In two-way interaction content is individually addressed to the user and the return channel carries a user response. Instant messaging is an example of this service type. (DVB Project Office 1995)

4. Operator and Vendor Business

Traditionally telecommunications operator business has been offering of telephony services to customers. The development of mobile TV and digital video broadcasting will give the operators a chance to deploy new business ideas and models. Additionally to telephony and Internet services they can provide different audio, video and data services on top of the digital video broadcasting architectures. These services include for example digital radio, mobile TV and weather information, that can all be received by portable devices, such as cell phones.

Operators can introduce different business models depending on the level of interaction of the services and by the type and variety of services they offer. The new broadcasting technologies offer operators new ways to differentiate. Operators can offer services for both, content providers and customers willing to pay for the content. Essential for the operator is that all of the offered services are profitable. Usually the operator offers content delivery services for content providers and access to the content services for users.

Mobile TV creates new business opportunities for the vendors as well. New technologies push the market and customers will adopt them. Vendors can offer new devices utilizing the technology and thereby answer the demands of potential customers. These devices comprise of network elements and mobile terminals. For the vendors network elements create new business to business opportunities as operators require new hardware to offer services and mobile terminals create new business to customers opportunities.

This chapter discusses the advantages and disadvantages of different service types for both operators and vendors.

4.1 Business Model for Local Interaction Services

Local interaction type services are the easiest to implement because they do not require a return channel. Mobile TV and digital radio can be easily offered and provided as local interaction type of services. The content can be delivered utilizing any of the previously discussed broadcasting techniques.

Operators can offer free content, premium services or services funded by commercials. In this model all the subscribers to a service will get the same content and therefore billing is also easy. Because the content delivered to each user is the same, the network utilization can be more easily predicted. In this model operators provide the content for the users and the distribution channel for the content providers. Operators can also create content of their own, for example a news service, and provide it to the users.

Vendors can offer network elements capable of utilizing mobile TV for operators. For private customers they can offer mobile devices that include a mobile TV receiver. If the device can be used for other telecommunications activities that require an operator the vendors and operators can offer the devices in collaboration.

This is probably the first type of service offered for customers by operators. The implementation and charging for the use of the service are easiest of all the types. Also this service type requires the least additional improvements if build on top of an existing infrastructure.

4.2 Business Model for One-way Interaction Services

One-way interaction type services require a return channel. The return channel can utilize a different network than the actual broadcasting network. The content can be delivered utilizing any of the broadcast networks. An example of a service in this category is television games. The return channel is used for user response and identification. Any existing telecommunications network that has a data channel reserved for user data transfer can be utilized as the return channel.

Operators can offer one-way interaction services in broadcasting environments with limitations. Services where the actual content is the same for all the users could be easily implemented. Those services include various polls, voting or television games. Operators can charge users for access to the content and for the use of the return channel. It is easy for the content providers and operators to collaborate in this model. Content providers can offer interactive content which leads to utilization of telecommunications networks and will provide more profit for operators.

For vendors this model will introduce the same opportunities as the previous model. Additionally it will push the demand for return channel equipment.

4.3 Business Model for Two-way Interaction Services

In a two-way interaction service the users receive the content via the broadcasting network but they also sent responses through a return channel and receive individual content based on the responses.

In this model the operator would provide the distribution channel for the content. The content would be individual to each user of the service. An example would be a video on demand service where users request the video clips they want.

Services that offer individual content for different users are harder to implement in a broadcasting environment. The major problem is that bandwidth in such environment is limited. The increase of user base will also increase bandwidth consumption which will eventually lead to problems. An example of such service is video on demand. The content is delivered to the user when requested. Users want different content at different times, but it should all be delivered through the same broadcasting environment. A working solution to this could be predefined content that is send in loops through the broadcast channels. Users requesting data when the loop is running have to wait until it starts from the beginning again. This will introduce delays that are not wanted. As an example news could be send on a video on demand basis. (Hrvoje 2006)

Collecting revenues in this model differs from the other two models that were introduced. Operators can charge users on a per view basis. Subscriber fees to the service can also be charged.

Again in this model vendors can offer network elements and mobile devices as in the two other models. Vendors can also offer complete platforms that support all of the activities required for a two-way interaction service.

4.4 Selecting the Business Model and Technology

Depending on their business strategy, operators can select any of the models described in this chapter. All of the models can also be combined and used together. The decision which model to use depends on the customer base and available technologies. The availability of the technologies depends on the network and mobile device manufacturers and vendors.

The local interaction model works with all of the three technologies described in this paper, it is the easiest to implement and charging for it's use is easy. The two remaining models require a return channel and user interactivity. Interactive programs were already popular during the times of analog television and the technology to adapt them to digital and mobile television is already available. This means that users are ready for such services and the success of them depends on the availability of the services. Also the the support of mobile devices for them will affect whether or not these applications are adopted by the customers.

Vendors can offer both, network equipment for operators and mobile devices for customers, regardless of the service type. Vendors can also collaborate with the operators and offer devices tailored to utilize the services these operators offer. The collaboration of hand held device manufacturers and operators plays a big role when the final decision of the used standard is made. Exploiting new geological areas highly depends on the operators and the availability of devices.

MediaFLO, DVB-H and T-DMB are all one-way technologies and therefore they require other networks, such as UMTS, to be used as a return channel for the interaction services. The need for a return channel will push the market for 3g networks. It also works the other way round where 3g networks offer more opportunities for the operators to offer services linked to digital video broadcasting.

5. The Current Market Tituation

The mobile TV market is still young and quickly evolving. New standards are developed and many of them are still in the trial phase. Before commercialization customers have to accept the new services that can be provided utilizing broadcasting networks. This chapter discusses the market situation of three competing standards designed to enable mobile TV.

DVB-H is a standard developed in Europe and is the market leader in Europe. Outside of Europe there have also been trials in North America, Africa, Asia and Australia. MediaFLO is a standard that was developed in USA and it is only used in North America. T-DMB is a Korean standard. It is widely in use in Korea where over 3 million devices have been sold since the launch of the service in 2005. It is also launched in Germany and further launches in Europe and China are expected throughout year 2007.

Of all these three standards DVB-H is most widely in use. After many successful trials it is the only standard commercially available in more than two countries. Trials of DVB-H are taking place in more than 40 countries and commercial launches in at least seven countries are planned for year 2007. Once it becomes the standard for mobile TV in a country it is hard to be replaced by other competing technologies. MediaFLO is commercially available in USA and trials have been conducted in UK. It is not available in rest of the Europe and therefore it has probably already lost the battle against DVB-H in Europe. T-DMB is offered in Germany and throughout the year 2007 new launches take place in Europe. Trials are also taking place in South Africa and Indonesia. Hand held devices that support T-DMB are already in stores and the number of them is increasing. (3GSM_Press_Release 2007)

The market is in it's early stage of development and it is fragmented. There are many competing technologies available and the availability of devices to customers is still quite low. Probable the early adopters of the services provided by these competing technologies are the ones who are technologically savvy. Therefore it is too early to say which of the standards will take the role of a market leader in the future, if any.

The major advantages of DVB-H compared to MediaFLO and T-DMB are that it is an open standard and it is widely supported by companies throughout the wireless world. This gives a wider amount of business opportunities for everyone involved in the mobile TV delivery chain.

6. Conclusions

Mobile TV is increasing it's popularity and it creates new business opportunities on a growing market. There are many different standards available for implementing mobile TV. The race for the market leader mobile TV standard has begun. Many trials have been conducted and a few commercial launches have already taken place. Currently DVB-H is the most widely accepted standard with the most trials taking place.

Mobile TV creates opportunities for all parts in the value chain. New infrastructure and devices are required and vendors can profit from the situation. Operators can offer more services for the users which is an opportunity to increase profit. For content providers mobile TV offers a whole new distribution channel.

The market is still young as are the standards. Therefore only future will tell how the new technologies and their applications are accepted by customers. Even though the trials so far have been promising there is no guarantee that mobile TV will be the next big hit. It is not the technology that will lead to wide adoption but the services provided on top of the technology.

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MOBILE BROWSING

Antero Kivi
Helsinki University of Technology, Networking Laboratory
P.O. Box 3000 FI-02015, FINLAND

Abstract

The browser is a core application used for many purposes in mobile handsets, especially in the context of data services. An overview of mobile browsing and related business dynamics was presented in this study by conducting a literature study.

The boundaries of browsing are neither clear nor stable. Various industry actors have different motivations for developing mobile browsers, dedicated browser-substituting client applications, or adapting web content for mobile handsets. Overall, the difference in performance between desktop browsers and mobile browsers defines the need of dedicated browser-substituting client applications at mobile handsets. However, support of a specific web standard does not give long-term competitive advantage over other mobile browsers. The relative bargaining power of mobile industry companies define the popularity of different browser applications.

Key Words
Mobile browser, mobile browsing, content adaptation

1. Introduction

The browser is a core software application in desktop and laptop computers. Early indications on the emerging usage of mobile data seem to imply that the browser is in a similarly important role for mobile handsets (e.g. Kivi, 2006). Increased usage of mobile data services is in the interest of all the major stakeholders of the mobile industry. Mobile operators hope to obtain new revenues to cover the decreasing voice and SMS driven ARPUs, equipment manufacturers motivate the sales of new handsets with features supporting data usage, while content owners could see the mobile as an additional distribution channel. Moreover, there is arguably much to gain by the end-users as well. The browser is in as central position in the use of mobile data services, as it is not only used for accessing web based services but also for finding 3rd party software applications for the handsets.

Previous research on the topic of mobile browsing is typically either related to mobile handset and browser usability (e.g. Roto, 2006) or web content adaptation (e.g. Laakko & Hiltunen, 2005; Lehtonen et al., 2006). In addition, many technical browser comparisons and ideas concerning the business dynamics related to mobile browsing by the user community can be found in the Internet. The purpose of this paper is to present an overview of the mobile browser market by conducting a literature study and some speculative discussion. After the introductory chapter, this paper presents the state of the art of mobile browsers in chapter 2, introduces the issue of supplying content to mobile handsets in chapter 3, and discusses related business issues in chapter 4. Concluding remarks are presented in chapter 5.

2. Mobile Browsers

The current state of the art in mobile browsing is presented in chapter 1) by describing some current mobile browsing usage patterns, 2) by introducing the web technologies supported by high-end mobile browsers, 3) by naming the most popular browsers and browser substituting applications, and 4) by discussing the importance of usability in mobile browsing.

2.1 Mobile Browsing Usage Patterns

True mobile browsing usage patterns can be studied with a range of different methods, as described in (Kivi, 2007a). A recent research has shown that the share of browsing related application protocols (HTTP, HTTPS) was almost 60% of all Symbian operating system originated/destined packet data traffic in the Finnish mobile networks in fall 2006 (Kivi, 2007b). Similarly, different browser applications constituted about 45% of the total packet data traffic created by handset applications and about 5% of the total time spent using different handset features (e.g. calling, camera, music player) of a panel of 700 Symbian S60 using Finnish consumers in fall 2006 (Verkasalo, 2007). While no major increase in the relative share of browsing compared to other applications was observed between 2005 and 2006, a three-to-fourfold growth in absolute traffic volumes was observed in these studies.

2.2 Web Technologies in Mobile Browsers

The most advanced mobile browsers currently (April, 2007) support a range of web standards (Forum Nokia 2006, Opera 2007b), including

- HTML 4.01
- XHTML MP 1.1
- WML 1.3 and 2.0
- CSS 1 and 2 (Cascading Style Sheets)
- JavaScript 1.5
- Flash Lite 2.0
- AJAX (Asynchronous JavaScript and XML)
- RSS 2.0 (Really Simple Syndication)
- SSL / TLS

However, comparing the support of different web technologies in different browsers and browser versions is not relevant considering the scope of this paper. In the end, all major web technologies will be supported by the significant browsers, and sustainable competitive advantage cannot be obtained by new browser features alone.

2.3 Mobile Browsers and Substitutes

A browser is a "computer program used for accessing sites or information on a network (as the World Wide Web)" (Merriam-Webster Dictionary & Thesaurus). A mobile browser (sometimes microbrowser or minibrowser) is a browser designed for handheld devices such as mobile phones and PDAs. Browsers can also be substituted by other software applications that, while sometimes fulfilling the above definition of browser, are not widely regarded as browsers.

Significant Mobile Browsers

Market shares of different mobile browsers are not easily available. Typical estimates are based on the market shares of different handset vendors, and thus neglect most 3rd party browsers. Moreover, identifying mobile browsers from traffic with the HTTP protocol header User-Agent field information typically used with desktop browsers has certain limitations, as described by Kivi (2007a). Currently (April, 2007), the most advanced mobile browsers include the following:

- Nokia S60 3rd edition Web Browser
- Opera Mobile version 9
- Safari for Apple iPhone
- Pocket Internet Explorer "Deepfish"

The most advanced browsers are not made for low-end devices, as their functions set requirements on the underlying operating system (e.g. Symbian S60, Windows Mobile, OS X for iPhone) and hardware. These browsers support the web standards listed in chapter 2.1 extensively, and also feature the overview layout mechanism described in chapter 2.4. (Nokia, 2005; Opera, 2007a; Apple, 2007; Microsoft, 2007).

One of the most popular browsers for mid-range to low-end devices is the J2ME based Opera Mini. Unlike the above web browsers, Opera Mini uses a proxy server from which all web content fetched. The proxy adapts and compresses the content to the lesser capabilities of low-end phones. Mobile browsers are not limited to those presented above. For advanced handsets, other browsers include NetFront and naturally the previous versions of Nokia S60 browser and Pocket Internet Explorer. In the mid-range, Nokia Series 40 and SonyEricsson handsets have proprietary browsers, whereas many low-end handsets from various manufacturers use Openwave's UP.Browser or Teleca's Obigo Browser.

Substitutes for Mobile Browsers

A browser is a very generic software application on both desktop PCs and mobile handsets, as implied by the browser definition provided above. The browser substitutes many dedicated applications, and is substituted by many others. Desktop computer browsers are commonly used for accessing email (webmail) and streaming videos (e.g. YouTube), for instance, while Google's approach seems to be to use the browser as another layer of abstraction for providing services such as calendar and office applications. In the near future, browsers will even include built-in support for P2P file sharing (Opera, 2006).

On the other hand, other applications have recently started to substitute browsers. RSS aggregators/readers are used to retrieve syndicated web content in order to reduce the time and effort needed to check a number of websites for updates, or for creating a personal information space. Nowadays, RSS reader features are also being built into web browsers. Widgets/gadgets are light-weight single-purpose applications that provide services on top of e.g. computer desktop or a web page. Widget services might include calculators, dictionaries, and provisioning of news headlines. Nokia recently announced there will be full widget support in future S60 releases (Nokia, 2007a). In addition, several J2ME-based mobile widget engines exist, including WidSets and BluePulse. Nokia's Channels media browser provides selected content from cooperating media companies to the mobile handset user. The content is downloaded to the handset, and browsed offline to maximize usability. Advertisements from the media companies are presented at startup. (Nokia, 2007b) There are also several dedicated clients for accessing Internet based services (e.g. Flickr), which are also direct substitutes for browsers. Thus, the boundaries of browsing seem to be quite hazy.

2.4 Usability and Mobile Browsing

The input and output mechanisms of mobile handsets are limited compared to desktop computers. New handsets nowadays feature large high-resolution displays, along with QWERTY keyboards and various other input methods in different handset form factors. The touch screen in Apple iPhone, while not being a particularly new invention, has gained much attention. As no keypad is needed in the device, a larger display can be fitted into the device. On the other hand, two hands are typically needed to use a device with a touch screen, resulting in mixed usability improvement. Nevertheless, combining touch screen with a full-featured browser could prove to be a major usability improvement.

Roto (2006) has studied web browser usability extensively, and participated in the development of the "Minimap" feature of the new S60 3rd edition browser. The browser is able to view web content with practically no modifications and preserve the original web page layout. Navigating web pages on a small display is facilitated by presenting a scaled down overview image of the page. The user can zoom into any part of the page to read the contents, while the amount of scrolling is reduced by the overview function. (Roto et al., 2006). An exemplary figure illustrating the Minimap overview mechanism from the Nokia S60 3rd edition browser is presented in the figure below.

Figure 1. Nokia S60 3rd edition browser layouts (original layout / overview layout)

Support for the argument of the short term nature of the advantage presented by implementing any specific browser features is well illustrated with the overview feature. The other "advanced" browsers listed in chapter 2.3 are now all including the overview feature in a current or upcoming browser version, despite Nokia's initial 1,5-year lead. Moreover, efforts of implementing a similar feature for mid-range phones using a proxy server have also been conducted recently (e.g. Lehtonen et al., 2006).

Most dedicated browser-substituting client applications, such as the Channels media browser, also offer a notable usability improvement compared to using the particular service with the browser.

3. Mobile Content

Browsing mobile content can be categorized in two dimensions. First, by the level of content adaptation required to browse web content with a mobile handset. Second, by the level of openness in accessing content with mobile handsets.

3.1 Content Adaptation for Mobile Devices

Mobile computing has some inherent disadvantages compared to using desktop computers and wired connections. Mobile devices tend to have less powerful CPUs, less memory (ROM and RAM), restricted power consumption, smaller displays, and differing input devices compared to desktop computers. Similarly, wireless data networks tend to have less bandwidth, more latency, less connection stability, and less predictable availability than wired networks. (WAP Forum, 2001) Thus, there is a need to adapt the web content originally designed for desktop computers when accessing it with a mobile handset.

There are many techniques to perform content adaptation, including transformations between XML languages and encoding of multimedia resources (e.g. quality, frame rate, resolution). Content adaptation is performed according to the delivery context, which includes information on e.g. user device capabilities, access characteristics, and user preferences. Adaptation is conducted in various places of the mobile web content delivery chain, and by different actors. There are three approaches for adapting content for mobile browsers: server-side, intermediate, and client-side.

Server-side adaptation

Server-side adaptation provides the content author maximum control over content delivery. Authoring can be conducted with different methods. In multiple authoring, different versions of the content for each browser class are created. In single authoring, only one version of the content is created and translated into format suitable by the client browser by the adaptation solution. (Laakko & Hiltunen, 2005)

Server-side web content adaptation is primarily conducted by service providers, and also at mobile operator portals that provide content exclusively for mobile handsets. An extreme example of server-side content adaptation is Nokia's Channels media browser described in chapter 2.3.

Intermediate adaptation (proxy adaptation)

Intermediate adaptation, or proxy server adaptation, is carried out with or without author-provided metadata or adaptation instructions. In intermediate adaptation, clients contact the proxy server instead of the real service provider servers to access the content. Proxy-based adaptation methods are typically based on some transcoding heuristics, e.g. a set of rules to perform adaptation tasks. (Laakko & Hiltunen, 2005)

Mobile operator WAP gateways are a classic example of intermediate proxy servers, as they translate (e.g.) HTML pages to the WML format suitable for most mobiles. The Opera Mini java browser also uses a proxy server to access Internet sites. The Opera proxy reformats web pages into a smaller width and also otherwise compresses the content, and delivers the requested pages to the mobile in a proprietary markup language. Google's search page for mobile handsets also transcodes search result pages to a narrow and compressed layout. There are also 3rd party solutions, such as Mowser (Mowser, 2007) and Skweezer (Greenlight, 2007), that offer proxy based web content adaptation for mobile handsets.

Client-side adaptation (browser adaptation)

Client-side content adaptation, or browser adaptation, avoids the issue of transmitting client properties to the server or proxy present in the other approaches. In client-side adaptation, a client device can use stylesheets (e.g. CSS) to format content in a browser, and browsers can also perform content adaptation similar to adaptation proxies to transcode media and documents more suitable for rendering. However, there are some potential efficiency issues, as the adaptation process is conducted at a small device instead of a server. Client-side adaptation can also be used together with intermediate and server-side adaptation to improve the user experience. Additionally, the browser can provide several ways to employ user preferences and delivery of context information to personalize a mobile handset's user interface and layout. (Laakko & Hiltunen, 2005)

Most of the popular mobile browsers, such as the Opera Mobile and NetFront, include the above-described functionality at the client-side.

3.2 Open and Closed Content

Mobile browsers can also be distinguished by the type of content to which they provide access. In the fully open model, or the "Internet model", content is accessible regardless of the browser provider, where as in the closed model the browser provider selects which content is accessible with the browser. Full-featured mobile web browsers provide open access to all web content, whereas dedicated clients and closed proprietary browsers (e.g. Nokia Channels) provide access only to a limited set of services, as dictated by the provider of the browser application. The various browsing solutions between these two extremes provide the content with some limitations due to technical or business-related reasons. Mobile operators, for instance, have often relied on the walled garden model by providing a closed or exclusive set content and services.

Content and service discovery is another topic closely related to both mobile browsing and the openness of mobile content, as companies providing these functions can favor some content over others. Mobile operator portals have traditionally been the primary source of mobile content. Recently, versions of Internet based web site (e.g. Google Mobile) and content (e.g. Mogmo) search engines for mobile handsets have emerged. Moreover, many 3rd parties are also providing databases on locally available real-world services for the search engines. Nokia has developed a mobile search application, which searches e.g. local services (e.g. restaurants, shops) and mobile-specific content (e.g. wallpapers, ring tones, mobile sites) using the search engines and databases of various international service providers. (Nokia, 2007c) Furthermore, recent reports indicate several large mobile operators are planning to develop their own mobile phone search engines to compete with traditional Internet search engines. (Telegraph, 2007) Apart from different search solutions, the dotMobi initiative that introduced a new top level domain name ".mobi" for easier addressing of web services accessible by mobile handsets is another solution for service discovery. A ".mobi" address should nowadays indicate a site has been adapted for mobile handsets. (dotMobi, 2007).

3.3 Summary of Mobile Browsing Solutions

The alternative approaches of providing the web on mobile handsets can be summarized in an indicative framework presented in figure 2. The horizontal axis of the framework ranges from mobile specific content to generic web content, with different degrees of content adaptation between the two extremes. The vertical axis ranges from closed content to open content, primarily referring to the variety of content and services accessible to users with a specific client application.

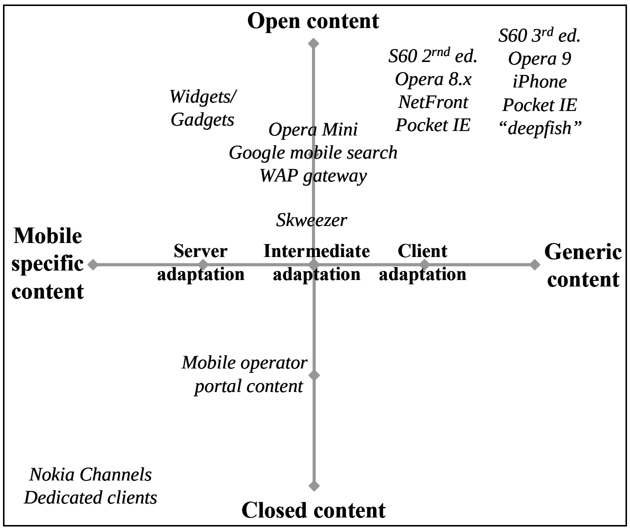

Figure 2. Illustration of mobile browsing solutions

4. The Business in Mobile Browsing

This chapter discusses different telecom and Internet players, and their business motives for developing mobile browsing software and adapting web content for mobile handsets. Moreover, the future of mobile browsing is shortly speculated.

4.1 Players and Player Motivations

Mobile browsing involves various telecom and Internet industry players. These actors have different motivations for developing mobile browser software and dedicated browser-substituting clients, or for adapting content for mobile handsets. Understanding the primary sources of revenue of each player will also reveal their primary motivations, and explain why some players are involved in several different approaches to improve the mobile end-user browsing experience.

Mobile Operators

Mobile operators currently make money primarily from voice calling and messaging services, and to a lesser extent, from data services. Operators don't develop web/wap browsers themselves, but sometimes provide dedicated handset applications (e.g. Elisa Mobi, Sonera Mobile TV) to facilitate the use of operator-provisioned per-transaction-charged data services. Operators also modify content for the browser both at the portal, and at the WAP gateway as the usage of Internet based services also generates revenues from the data transmission fees. Operators often sell mobile handsets as well, but such activity is arguably less important as a source of revenue, and can be considered as a supporting activity.

Handset Vendors and Software Platform Providers

Handset vendors sell handsets, but also promote handset operating systems (e.g. Symbian, Windows Mobile) and software platforms (e.g. Nokia S60). For these companies, revenues primarily come from handset sales and operating systems / software platform licenses.

Many platform providers develop browsers as a built-in functionality of the handset platform, but also support dedicated applications in cases where the browser does not provide sufficient user experience. As the browser is at the core of data usage in mobile handsets, developing a capable browser is important for the platform provider. More speculatively, the browser could be seen as the future user interface of mobile handsets, which should motivate the platform provider further, as controlling a dominating software platform also provides means to push other software applications and services to end-users. Handset vendors and platform providers usually do not perform content adaptation (expect at the client-side). In general, handset vendors gain from the increased usage of any mobile data service, as it will make new and more capable handset features more attractive to both operators and end-users.

3rd Party Software Developers

Third party software companies (e.g. Opera, NetFront) develop both browser software and dedicated browser-substituting client applications. They license the software to handset vendors, mobile operators, and end-users. Sometimes, branded and customized versions are also provided for increased license fees. Some 3rd party browsers inherently include a content adaptation proxy (e.g. Opera Mini), whereas others perform content adaptation at the client-side. In general, software developers involved in mobile browsing also sell other software for desktop computers and mobile handsets, but might rely on revenues from advertising and other services as well.

Service Providers

Service providers sell their content and services to Internet users, and the mobile presents another potential distribution channel for them. If mobile users are targeted specifically, some degree of content adaptation is most likely conducted by the service provider. Service providers do not develop browsers, but might develop dedicated applications (e.g. Gmail and Flickr clients, Nokia Channels) for attracting mobile users. The emergence of standard-fulfilling browsers is in the interest of service providers as it decreases the need for content adaptation and versioning at the server-side. Advertisements are also a source of revenue for service providers, and might explain the involvement in mobile browsing of some players (e.g. Skweezer).

End-Users

End-users are involved in mobile browsing not only as browser users, but also as browser developers in different open source initiatives. The motivations of open source developers for contributing to specific projects are various, and are not in the scope of this study. Examples of open source mobile browsers include Minimo, which essentially is a small version of Firefox for Windows Mobile offering many features of its desktop counterpart. Minimo is a free open-source web browser that is based on the Mozilla codebase. (Minimo, 2007). WebKit is an open source web browser engine used in e.g. Apple's Safari browser and the S60 3rd edition browser. WebKit's HTML and Javascript code are originally based on the KHTML and KJS libraries from the open source KDE (K Desktop Environment). (WebKit, 2007). The role of open source and proprietary code in the S60 3rd edition browser is described in detail by Grassel et al. (2006). End-users are also sometimes involved in content adaptation, as e.g. in the case of Mowser.

4.2 Future of Mobile Browsing

The future of mobile browsing is discussed in this chapter from various perspectives: 1) the need for adapting content for mobile handsets in the future, 2) the future of open and closed content, 3) the relation between mobile browsers and dedicated clients, 4) the potential of different mobile browsers for dominating market, and 5) the potential for new end-user services provided by mobile browsers.

Adapted vs. Non-Adapted Content

Content adaptation is probably the most fundamental issue related to the future of mobile browsing. Will content adaptation for mobile handsets still be conducted in the future, or will it just be necessary during in a transitory period?

Considering the device perspective, low-end handsets sold in the developing countries will surely require content adaptation the longest. Moreover, industry spokesmen have recently estimated that many people in the developing countries will access the Internet for the first time in their life using a mobile handset instead of a desktop/laptop computer, as building wireless access networks is cheaper than building fixed connections in these regions. From this perspective, the low-end handsets should also be able to provide a rich browsing experience in the near future. Whether or not all handsets will someday do without adapted content is not known presently.

From content perspective, new standards effectively separating presentation from content could also provide an answer to the necessity of content adaptation. While content would still be adapted appropriately for each end-user device, the adaptation process would be light and produce the same information for all device types.

Open vs. Closed Content

Proponents of the Internet model often forecast the demise of the walled garden business model. On the other hand, the usability advantages provided by dedicated client applications over mobile browsers might justify their existence also in the future (see the chapter below), and thus ensure some role for closed content provisioning from this perspective as well. Service discovery also plays a role in deciding whether any closed content can prevail. The emergence of operator search engines could provide an opportunity to provide exclusive or closed content to end-users.

Browsers vs. Dedicated Clients

Another important question related to content adaptation is the balance between mobile browsers and dedicated client applications. In a sense, using a dedicated client is the same as using content fully adapted for the particularities of the handset. Mobile handsets lag desktop computers with some years regarding processing speeds and memory capacities. Similarly, mobile browsers do not always support the most recent web technologies that desktop browsers support. As implementing browsers for mobile handsets involves some compromises, mobile browsers will likely never catch up with their fixed counterparts in full. Thus, one could argue that the longer it takes to implement desktop level web technologies to the mobile environment, the more dedicated mobile client applications will emerge for specific use cases.

Most Popular Browsers

Forecasting the future success of specific browsers is as simple as forecasting the success of handset vendors and mobile operators. Some speculation can nevertheless be conducted.

In general, the browser software ends up in mobile handsets in three ways: it can be preinstalled by the handset vendor, it can be preinstalled by the operator, or it can be installed by the user after the purchase. Essentially this means that 3rd party developers cannot obtain significant market share even with extensive marketing efforts unless they cooperate with device vendors or operators. From this point of view, major device manufacturers such as Nokia with its S60 browser are in the best position to push their solutions to the mass market. Opera will need to rely on close cooperation with large operators, who are in the position of affecting browser adoption through handset customization especially on markets where handset bundling is in an important role. The success of Microsoft's Pocket IE is tied to the success of Windows Mobile platform primarily targeted for business users. While business users are not be as big a segment of the market as consumer users, Microsoft will likely try to leverage the dominant possession of the Windows operating system in desktops/laptops to spread the user base of Windows Mobile handsets to all mobile users. Furthermore, if Apple iPhone remains a high-end niche product similar to Apple's desktop and laptop computers, its browser will not gain a significant market share either. On the other hand, if Apple is able to reproduce the success of the iPod in the mobile domain, its browser would also grab a significant share of the mobile browser market. Nevertheless, Apple can set the standard of mobile browsing in the same way it has done with desktop computer operating systems.

New End-User Services

The browser and browser-substituting dedicated client applications are likely to enable the use of various current and future web services for the mobile users. Similarly, browsing software might well be used in some truly new mobile services that utilize the inherent advantages of mobile handsets such as mobility and location-awareness. However, the emergence of genuinely mobile services is a broader topic that is not primarily related to browser software. Thus, it is not possible the say that the browsing software will be in a central enabling role for such services.

5. Conclusion

The boundaries of browsing are neither clear nor stable. The browser substitutes many software applications, but is also itself substituted by many others both in the fixed and mobile domain.

Various telecom and Internet industry actors have different motivations for developing mobile browsers, dedicated browser-substituting client applications, or adapting web content for mobile handsets. These approaches to mobile browsing are also partly targeted to different user segments, as technologically savvy early adopter users can easily overcome difficulties while mass market users require better usability from the client software.

The difference in performance between desktop browsers and mobile browsers defines the need of dedicated browser-substituting client applications at the handsets: improvements in desktop browsers increase the demand for dedicated handset applications, improvements in mobile browsers decrease the demand for dedicated handset applications. However, the support of a specific web standard does not give long-term competitive advantage over other browsers, and does not decide the popularity of a mobile browser. Instead, the relative bargaining power of handset vendors, mobile operators, and 3rd party software developers dictates which browsers are preinstalled in the handsets and adopted by the majority of users.

All in all, the future of mobile browsing regarding the necessity of content adaptation and dedicated client applications merits further debate.

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RSS AND MOBILE MULTIMEDIA SERVICES

Juan José Rodríguez Ponce
Helsinki University of Technology
jjrp78@yahoo.com

Abstract

The present documents intends to describe the web feed format Really Simple Syndication, and to reflect on possible business models than can be applied to it.

Key words

RSS, podcast, multi media, syndication, business model

1. Introduction

Among all currently available telecommunication media, Internet stands out at fulfilling its purpose of transmitting information. The ability to present information combining multiple forms of information such as hypertext, audio, video, interactivity etc gives Internet an advantage that makes it incomparable with any other communication tool. Allan Paivio, an emeritus professor of psychology at the University of Western Ontario states in his dual-coding theory [1] that the more codes one has for a given memory the more likely one is to remember that information, in other words, receiving a piece of information via different communication channels (audio, image, etc) facilitates the information assimilation.

In spite of the obvious benefits of including powerful (in terms of information sharing) media such as video and audio, their introduction to Internet has been slow. Such kinds of a media demand a lot of resources for the available transmission channels for internet, making the audience's experience unsatisfactory. Typically when accessing video via Internet the user would have to deal with the following disadvantages:

- Not immediate response. Once requested, a video can not be shown immediately since a considerable amount of information is required to be received to start its reproduction.
- The wait is longer than the video. Usually the length of the video is shorter than the time one has to wait to start watching it
- Bad quality. As an attempt to reduce the two disadvantages mentioned above videos and audios are sometimes compacted by diverse methods loosing some of its quality

However, a solution to these and other barriers has risen with a small change in the used method to request a video. Instead of triggering the downloading of a video with a click one can previously define what kind of content is interested in, allowing the downloading of such content as soon as it is available. In this manner when the user attempts to watch a video it is already stored in the local hard drive of his device avoiding the long wait for the downloading. This is the idea behind Really Simple Syndicating (RSS) applied to multimedia services.

In the next section I will introduce the technical issues related to RSS-based mobile multimedia services, to continue with a description of the current status of related standards. After that some end user services and vendor's business models will be described. A special section dedicated to discuss the way RSS contribute to legal media distribution is included then to conclude with a meditation on the benefits from every actor's point of view gained with RSS.

2. Overview of technical issues

2.1 RSS file format

RSS is itself a variety of XML. It conforms the World Wide Web Consortium's specification for XML 1.0. The whole description of the service must be encapsulated in a mandatory <rss> element, and is obligated also to include a version element which specifies the version of RSS the document conforms to. This paper's description of RSS format is based on version 2.0 of RSS documents.

In the next level subordinated to the <rss> element is a single <channel> element which contains metadata and description of the content provided.

The Table 1 presents a list of the required channel elements, each with a brief [2].

Table 1: Required Channel elements

Element	Description
title	The name of the channel. It's how people refer to your service. If you have an HTML website that contains the same information as your RSS file, the title of your channel should be the same as the title of your website.
link	The URL to the HTML website corresponding to the channel.
description	Phrase or sentence describing the channel.

Some of the most important optional channel elements are listed in Table 2 with a description taken from [2].

Table 2: Optional Channel elements

Element	Description
language	The language the channel is written in. This allows aggregators to group all Italian language sites, for example, on a single page.
category	Specify one or more categories that the channel belongs to.
docs	A URL that points to the documentation for the format used in the RSS file. It's probably a pointer to [2].
skipHours	An XML element that contains up to 24 <hour> sub-elements whose value is a number between 0 and 23, representing a time in GMT, when aggregators, if they support the feature, may not read the channel on hours listed in the skipHours element.
skipDays	An XML element that contains up to seven <day> sub-elements whose value is Monday, Tuesday, Wednesday, Thursday, Friday, Saturday or Sunday. Aggregators may not read the channel during days listed in the skipDays element.
cloud	It specifies a web service that supports the rssCloud interface which can be implemented in HTTP-POST, XML-RPC or SOAP 1.1. Its purpose is to allow processes to register with a web service that enables client software to be notified of updates to RSS documents.

An element of <channel> that is worth to have a separate mention due to its relevance is the element <item>. This element usually contains the dynamic part of the RSS, describes the content the RSS is intended to distribute as well as the access point of the same.

A <channel> may have as many <items> as necessary. An <item> could describe for example a story in a newspaper, for this purpose <item> must contain a synopsis of the story, and the link point to the full story, for instance a URL. All elements of an item are optional, however at least one of title or description must be present.

Table 3: Elements of item

Element	Description
title	The title of the item.
link	The URL of the item.
description	The item synopsis.
author	Email address of the author of the item.
category	Includes the item in one or more categories.
enclosure	Describes a media object that is attached to the item.

The element <enclosure> is the one that allows including multimedia files in RSS files. This element must contain an URL indicating the location of the media file, length in bytes, and type. Bellow is an example of an <enclosure> element.

```
<enclosure
url="http://www.scripting.com/mp3s/weatherReportSuite.mp3
" length="12216320" type="audio/mpeg" />
```

With this information an aggregator knows in advance what kind of file is going to get, and its length allowing to apply criteria to schedule its downloading time and filtering.

2.2 A use case

The following example presents a use case scenario to illustrate for a better understanding the way RSS works. Distribution of media via RSS takes place basically in 4 steps.

1. The publisher creates content and publishes an RSS file, which in the future will be referred to as feed. The feed most complain with the format of an RSS file described in the previous section, relating among other things the kind of media is intending to publish. The file http://www.cbsnews.com/htdocs/mp3/podcast/podcast_cbsnews.rss is a good example of a feed. The element <enclosure> in this file clearly describes the content to be distributed as a video of format m4v, and provides its location:

```
<enclosure
url="http://www.cbsnews.com/htdocs/temp_videos/hartman_h
oopdream0223.m4v" type="video/m4v"/>
```

2. On the client side a user interested in receiving information from this video news provider adds the URL of the feed in an application called aggregator. The user may also define how often the aggregator

should check for updates and the preferred time to download the new content.

3. According to the criteria specified by the user, the aggregator will check for updates in the feed and download the new content, if present, to the local storage facilities of the device.

4. Finally, when the user notices the new content, can trigger its reproduction.

3. Current Status of Related Standards

Many technologies in their early stages have had to face a long process to reach a true standardization in its use. Due to their potential profitability, more than one companies and groups usually pull in different directions claiming to possess the official standard. RSS unfortunately is not an exception.

The most important branch of standards is leaded by Dave Winer, who collaborated in the development of the first standard for syndicating content. The porpoise of this first standard was to be used in My Netscape portal. This standard has evolved until its version 2.0.8 which is widely used specially, but not exclusively, to provide text content for news services. In the year 2003 the RSS Advisory Board was founded as an independent organization to support the Really Simple Syndication (RSS) format.

A second group began a new syndication specification called Atom in response to a recognized dissatisfaction with the standard RSS 2.0. Their work has been adopted by the Engineering Task Force (IETF) leading to the publication of the specification RTF 4282. Work on the publishing protocol of Atom is still ongoing.

It is worth to mention that none of those two branches stands out, nor dominates the market; however both follow in essence the same modus operandi described in previous chapters of this paper.

4. End-User Services and Vendor's Business Model

In late 2000 Dave Winer included in the RSS specification[3] the element <enclosure> originating what today is known as podcast (term popularized by Apple computers). Originally conceptualized as a tool for end users to produce their own "radio like" shows distribute them, podcast has evolved into a media potentially more profitable than the radio itself. Cameron Reilly, a co–founder of the Podcast Network mentions in [4] four characteristics of podcast that gives it an advantage over conventional media such as radio and television:

> *Time shifting*. User can reproduce the content at any time. It is not tied to the transmitter's schedule anymore.
>
> *Portability*. Can be reproduced in portable devices such as cellular telephones, Palms etc.
>
> *User Control*. Content can be customized.
>
> *Global Coverage*. Since it uses internet as transmission media, it can be accessed anywhere.

Depending on the size of audience of a specific podcast as well of on the perceived value of the podcast for the audience, and willingness of the listeners to directly (through electronic payments) or indirectly pay for podcast (listening advertisements for instance) one or more of the following business models can be adopted.

Sponsorship.

For podcast with a large audience and which content can be related with a particular sponsor this kind of revenue (which has been used before for tv and radio) makes a lot of sense. Volvo for instance would be very interested in sponsoring a podcast like Autoblog.com (http://autoblog.com) which audience is a potential customer for them.

Sponsorships tend to be less intrusive and better accepted than advertising. Durex for example increased the traffic to their web page after sponsoring a popular podcast called "Dawn and Drew Show" [5].

Advertising

Advertising has been historically the most widely adopted revenue strategy for broadcasts producers. The idea behind advertisement as a business model is to deliver to advertisers a large amount of audience as a product.

"the [broadcasting] model starts with the premise that the real value derives from the audience that consumes the music, rather than from the product itself. Put another way, the audience is the product that is delivered to marketers."[6]

An additional advantage for podcast over other media is that it is easier to guess some characteristics of the audience. A podcast is aimed to a specific audience with a specific interest. This quality can be exploited for marketing purposes.

Listener Donations

A listener's donation model has been also adopted for some podcasters. In this scheme subscribers are asked to pay a volunteer tip or donation to support the podcast. The donation is given according to the listener's appreciation for the content. An example of this model is the podcast http://www.thepodcast network.com/gday_world.

Cooption

Basically this model consists in making already available content (conventional TV or radio shows) in a podcast format. The idea behind this model is the fact that the audience is driven to reproduce the content merely because of a desire of accessing it in a time or space where is usually unavailable and not for a desire of accessing radical new kind of content.

“Los Angeles station KCRW recently began podcasting its news and public affairs programs. The station’s Web master, Jason Georges, told United Press International that, for now at least, podcasting is a relatively cost–free proposition. ‘The money involved in producing the podcasts is no more than the money we spend on our existing online budget for bandwidth and staffing ... If it grows exponentially, then we’ll have to look at buying more bandwidth”[7]

Subscription models

The merely legend of “subscribe free” appearing when subscribing to any podcast using apple’s itunes suggests that in the future this service might not be free anymore. A model in whish Apple may charge a quote to the user for an unlimited (or limited) access to a large number of podcast via their media player might be implemented.

The revenue then could be split among apple and the podcast producers based, for instance, on the amount of audience. Individual Podcast producers with an already gained reputation may choose to sell their content directly to the final consumer as well.

6. RSS and Digital Right Management

RSS in a nutshell is a media distribution technique which principal contribution to the mobile environment is to change de downloading time of the media in such a way that the user does not have to wait a long period of time when he feels the desire to play a particular media file. This contribution has a special relevance when it comes to mobile devices since typically this devices operate in networks with limited bandwidth.

It has been discussed different business models that can be applied with different sources of revenue. In the particular case of subscription models the end user directly pays for the content and there is no other income supply for the producer. In this case the media is vulnerable to illegal distribution just as many other conventional distribution media such as compact disc.

The solution that the industry has applied to prevent illegal distribution of content is Digital Right Management (DRM). RSS can make use of some DRM methods without loosing its downloading time shifting advantages.

A common used method of DRM is encryption of the content. “To protect content against reaching everywhere, it must be cryptographically bound to some entity. Binding is done using some key that only this entity has possession of. Therefore, the device, representing that entity or being that entity, must be able to store keys securely.
The key used for binding is the bare minimum. Most content protection schemes utilize a larger set of permanent keys, all of which have to be securely stored. Examples are domain keys, group keys, and class keys. Secure storage may also be required to store other pieces of secure information, such as links information and rights objects that are cached, so they do not need to be processed per each playback”[8].

In this manner encrypted content can be distributed through RSS to be reproduced later on in an aggregator application capable of storing the required keys to decrypt it. The producer can be sure then that his content will be protected and can only be reproduced if the final user acquires the necessary key (which can only be acquired by paying for it).

7. Actor’s Benefits

Three actors can be mention to be involved in media distribution business; media producer, media consumer and operator.

Media producer. For the producer of the media RSS is one more available distribution channel. The ways this actor can benefit from RSS were already discussed in section 5 however it is worth to mention that the author’s opinion is that depending on how RSS evolve, it can be act as an alternative media distribution to simply promote other distribution channels. Radio and TV are responding to the launching of new media distribution techniques. TV services with storage capacity that allow recording of previously aired programs for future reproduction are being launched. Radio transmissions with CD sound quality are being developed. Therefore it is hard to predict if RSS will be as popular as its competitors but it is worth for the media producers to launch products distributed through RSS as an alternative distribution channel.

Media Consumer. There are currently no other distribution media that includes all the four advantages of RSS; time shifting, portability, user control and global coverage.

Time shifting and portability constitute a major advantage for mobile users as this kind of devices usually deal with limited bandwidth networks.

Operator. Currently it can not be told that distribution of media through RSS represents a significant amount of traffic, however as this distribution media becomes more and more popular and is targeted to distribute media files that are typically big they might represent a significant flow of data in the future. Fortunately for operators the time in which this significant flow of information will be needed can be predicted as it is intended to be during night time. Operators may take advantage if this predictability of RSS by setting special fares for night time use of the bandwidth.

8. Conclusion

RSS has proved to be efficient at distributing media, and certainly to have some advantages over its most popular competitor radio and TV (traditional and over the internet).

Among these advantages the following can be mentioned; *Time shifting*. User can reproduce the content at any time. It is not tied to the transmitter's schedule anymore. *Portability*. Can be reproduced in portable devices such as cellular telephones, Palms etc. *User Control*. Content can be customized. This also implies that what the customer likes can be deducted and used for marketing purposes. *Global Coverage*. Since it uses internet as transmission media, it can be accessed anywhere.

This advantages allow the implementation of different business models without deprive us from the implementation of other conventional ones.

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DRM ON LINUX-DRIVEN MOBILE TERMINALS

Ralf Ewers
Helsinki University of Technology
Telecommunications Software and Multimedia Laboratory
P.O. Box 5400, FIN-02015 TKK, Finland

Abstract

Linux is the Open Source community's biggest prodigy and the most known product that ever arose from this community with Linus Torvalds as its intellectual father. This operating system is becoming more and more popular with mobile devices such as mobile phones, internet tablets and music players. The philosophy of Open Source software is to provide free access to programs and their source code. Everyone is free to change the software and redistribute it. DRM, however, is the mechanism to restrict or deny users' access to content. How do these two contradictions fit together? This paper deals with the technical possibilities of implementing DRM into Linux systems on mobile devices and the related political discussion driven by the differences between the Open Source community and the stakeholders trying to utilize Linux for their business. Furthermore it gives an insight in the content provider business models for earning money in this specific branch and the impact on device vendors.

Key Words: Digital Rights Management, Linux, Mobile Devices

1. Introduction

Mobile terminals – especially mobile phones – are becoming more and more complex. Some years ago the only purpose of a mobile phone was to make phone calls or to write text messages. The operating systems for these devices were merely proprietary software of the device vendors. The whole system was more or less closed. Today the number of features of these devices is increasing enormously. Thus mobile device vendors are combining their efforts to create flexible high performance operating systems that make these devices small multimedia computers. One approach to face today's and future needs in reference to the stakeholders of the mobile market is the use of the free operating system Linux. It was back in 2003 when Motorola launched its first mobile phone powered by Linux (Ward 2003). It is presumed that the operating system will be used in 8.1 million phones in 2007 and the number is supposed to increase up to 203 million in 2012 (ABI Research 2007). Based on new functionalities content providers see a new medium for consuming and selling their content arising. By utilizing the providers' networks as a new distribution channel also providers are hoping to gather a piece of the cake. As assumed by the majority of the content providers strong protection for their goods is necessary to make this new model profitable for them. This strong protection can be achieved through the use of Digital Rights Management but its use in Linux driven devices is quite a bit controversial. Linux, as the most known creation of the Open Source community, was – and still is – developed following the philosophy of free access to programs and their source code whereas DRM tries to restrict the access to content. This paper gives an overview of the technical and political issues related to this much discussed topic. It gives information about the existing and developing standards and explains the influence on the content providers' business models. Furthermore the strategy of the terminal vendors plays an important role for the success of Linux in the mobile market and thus this paper also talks about the strategies of different vendors.

2. Technical and Political Issues

To foreclose all the suspense I would like to cite Linus Torvalds' comment sent to the Kernel Mailing List in April 2003 regarding Digital Rights Management (DRM) and Linux: "I want to make it clear that DRM is perfectly fine with Linux!" (Torvalds 2003). To understand the political discussion about DRM in the context of Linux this chapter begins with the explanation of technical problems that arise through the approach to utilize DRM in Linux.

2.1 Open vs. Closed

To describe the functionality of DRM systems I have adopted the DRM Reference Model from Hagenhoff (2006). I will concentrate on the client side of this model. For further information about the whole DRM system I refer to Paussu (2007). As illustrated in figure 1, the DRM controller gets the encrypted content file and the encrypted license. The license is a file that contains the rules and constraints that describe how the user is allowed to use the content. The consuming application (e.g. a media player) gets the decrypted file from the DRM Controller.
Here lies the problem within the openness of Linux (or vice versa the closeness of DRM). As soon as the DRM controller has decrypted the content the content becomes unprotected. As everybody is allowed to modify the operating system one could just write an alternative media player, file browser, or whatever kind of application that could do what ever the user wants to do with the file.

To overcome this problem the industry found two approaches. The first is to implement a whole DRM stack including the applications that are allowed to use the protected files. The files will only be decrypted for these special applications. For all other applications the

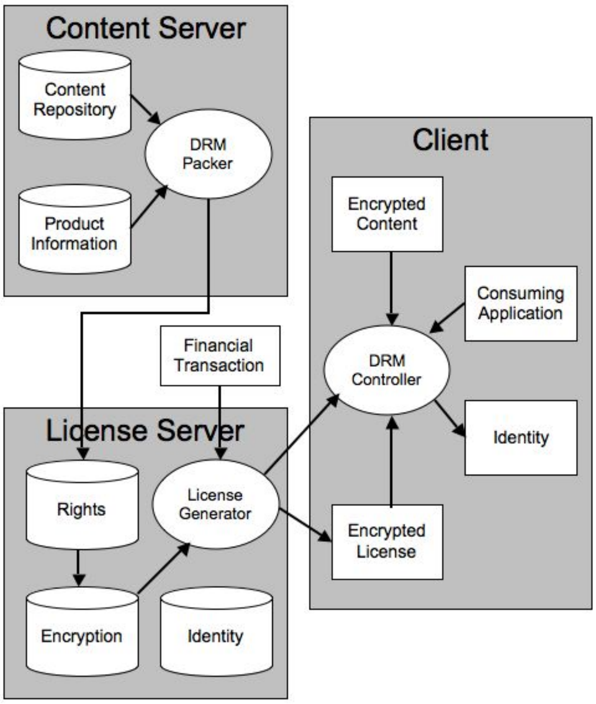

Figure 1: DRM Reference Design

access to the encrypted content is denied. This stack has to be closed and it has to be impossible (or at least very hard) to look into the stack. This would make it difficult (or impossible) to overcome the restrictions defined in the license of the protected file.

The second possibility is a so called 'firmware lockdown'. For this approach the hardware on which the operating system is running checks if the version of the operating system is exactly the one that the vendor has delivered with the system. If anybody ever changes a part of the system the hardware refuses to boot the system. This means if somebody would for example try to install another media player that disobeys the restrictions of the license attached to the content file the system would just not boot anymore until the user installs the original operating system back to the device.

2.2 Controversy

Linux is licensed under the GNU General Public License (GPL) Version 2 (Free Software Foundation, 1991). The first mentioned approach doesn't violate the license. The vendor who uses Linux in its device can add software to the system without putting this additional software under the GPL. So every company can add a stack in the above mentioned way to implement DRM into its device using Linux.

The second approach is more controversial. The Free Software Foundation mentions four freedoms that every user using software under the GPL should have:

- The freedom to run the program, for any purpose
- The freedom to study how the program works, and adapt it to your needs. Access to the source code is a precondition for this.
- The freedom to redistribute copies so you can help your neighbor.
- The freedom to improve the program, and release your improvements to the public, so that the whole community benefits. Access to the source code is a precondition for this.

Richard Stallman, founder of GNU, wants to have significant changes in the upcoming version 3 of the GPL to forbid this approach – as he calls it – 'tivoisation' (after a company that uses this method for its Linux driven Set Top Boxes). He states that the second freedom would be turned into a shame because it makes it only theoretically possible to adapt the system to your needs. As mentioned above, Linus Torvalds sees this in a different light. To be able to use the 'tivoisation' method a company must sign the kernel image. This means that they give the operating system a unique fingerprint to have it identified by the hardware. Torvalds (2003) gives the following reason for his point of view: "I think there are many quite valid reasons to sign (and verify) your kernel images, and while some of the uses of signing are odious, I don't see any sane way to distinguish between "good" signers and "bad" signers."

3. Standards

Technically it is possible to implement every DRM standard into the Linux operating system. In this chapter I will explain the most popular systems that have been implemented into Linux. For a more complete summary of the existing standards I refer to Paussu (2007).

3.1 Open Mobile Alliance DRM

The Open Mobile Alliance (OMA) is a consortium founded by the big players in the mobile content and services business. Among the nearly 200 members are companies such as Nokia, Samsung Electronics, Sun Microsystems, Siemens, Ericsson, AOL Time Warner and TeliaSonera (Open Mobile Alliance 2007). OMA defines the scope of its DRM system as follows: "The scope of OMA DRM is to enable the controlled consumption of digital media objects by allowing content providers to express usage rights, for example, the ability to preview DRM content, to prevent downloaded DRM content from being illegally forwarded to other users, and to enable superdistribution of DRM Content. The OMA DRM specifications provide mechanisms for secure authentication of trusted DRM Agents, and for secure packaging and transfer of usage rights and DRM Content to trusted DRM Agents (Open Mobile Alliance 2006). The OMA DRM 2.0 specification was approved in 2006 and is used in numerous mobile phones (either version 1.0 or 2.0). It is mainly used for content such as ring tones and pictures but can also be used for music or videos. The functionality is similar to other DRM systems: Before delivery the content is encrypted. Afterwards a Rights Object – an XML file – is created that specifies the constraints and permissions associated with the content. The content cannot be used without this Rights Object. A DRM Agent is responsible for the enforcement of the constraints and permissions defined in the Rights Object. This DRM Agent is a trusted component of the device (in the reference design mentioned before this was the DRM controller). The Rights Object is cryptographically bound to a DRM Agent and can be accessed only by one specific Agent. This allows the superdistribution of content. This means that somebody could for example share a ring tone with another person (e.g. via bluetooth). The second person than has to request a new Rights Object for his/her DRM Agent/mobile device. The Rights Object can also be bound to a domain of DRM Agents. Thus e.g. a song could be used on a user's mobile phone and also on his PDA. (Open Mobile Alliance 2006).

OMA DRM is an inherent part in several Linux distributions for mobile devices. The probably best known is the Qtopia distribution from Trolltech that uses the OMA DRM implementation from Beep Science. Qtopia is used in mobile phones from several companies such as Motorola as well as in Sony's Mylo personal communicator.

3.2 Windows Media DRM

Because of its integration in several versions of Microsoft Windows the Windows Media DRM is becoming more and more popular. Today several music download portals such as MSN Music, MusicMatch, Napster and Rhapsody To Go already use it. Microsoft's first version of the system worked only on personal computer platforms. The new version of the DRM – called Janus – now works with a wide range of devices such as mobile phones, PDAs and Set Top Boxes. When it comes to portable devices and lower performance compared to personal computers, the system uses a 56-bit DES encryption and 64-bit RC4 algorithm (compared to 128-bit AES encryption with a 1024-bit RSA for personal computers). It uses a Private Key Infrastructure (PKI) with a 160-bit private key and an 80-bit public key. The private key has to be stored on the mobile device for decryption. The DRM requires the device to have a unique serial number to identify the device. For tracking the expiration dates of the licenses it requires a real time clock within the device. In Microsoft's system the implementation of the DRM Controller is called "Windows Media Rights Manager".

The functionality is similar to the OMA DRM with a typical license server architecture (Figure 2). The process server – a license clearinghouse server – provides the licenses for the encrypted content files. It holds records that define the specific rights, terms, conditions, and business rules for a given content file and creates a Windows Media Rights Manager license based on the information given by the content provider. This file is sent together with the content file to the customer's device where it can be decrypted with the above mentioned keys and algorithms.

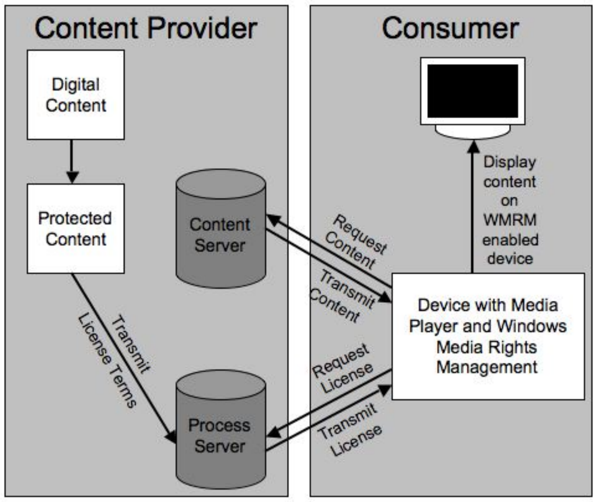

Figure 2: Windows Media DRM

Windows Media DRM is not very widespread among Linux devices. By now there is no Linux based mobile phone with this technology implemented but Motorola has announced a Linux based mobile phone that will support Windows Media Audio with Janus DRM (in combination with OMA DRM v2.0) for the first half of 2007 (heise 2007). The phone is based on a MontaVista Linux Kernel (LinuxDevices 2007). The company Sasken provides a multimedia subsystem for mobile phones that is also available for Linux and provides support for Windows Media DRM (Janus) and OMA DRM 2.0 (Sasken n.d.). The application/codec stack has already been licensed by the Chinese ODM (Original Design Manufacturer) Wistron NeWeb Corp for several Linux mobile phones due in early 2007 (LinuxDevices 2006).

3.3 Other Approaches

The above-mentioned approaches are designed for locally stored content. But when it comes to broadcasting and streaming content the situation changes a little bit. Traditional pay TV makes use of the concept of conditional access (CA). This approach regulates only the viewers' access to the streams – the service - but it does not regulate the reuse of received streams – the content. For mobile TV more sophisticated approaches are required. Therefore the creators of mobile TV established standards for service purchase and protection (SPP).

DVB-H for instance utilizes different frameworks for the service purchase and protection. Their function is the encryption and delivery of the whole broadcast stream. One component of these SPPs is the DRM system. The DVB-H group did not define a specific standard yet. At this time four different systems that use different DRM approaches can be used:

- 18Crypt
- Open Security Framework (OSF)
- DRM profile
- OMA BCAST Smartcard profile

18Crypt and DRM profile both utilize OMA DRM 2.0 for rights object management (Argillander 2007). They are very similar and offer both service and content protection for broadcast and streamed services (Joint Mobile TV Group 2006).
The Smartcard profile from OMA's broadcasting working group BCAST makes use of so called Universal SIM ((U)SIM) cards to identify users. It is mainly used for the Multimedia Broadcast Multicast Service (MBMS) and the Broadcast and Multicast Service (BCMCS) but also generalizes these techniques to support other broadcast networks such as DVB-H. It extends MBMS and BCMCS to provide DRM functionality. It can also utilize OMA DRM 2.0 for content protection.
The Open Security Framework (OSF) is a conditional access system. It only defines the signaling framework. Techniques such as the implemented DRM system are proprietary (Joint Mobile TV Group 2006).
Companies such as the CyberLink Corp. offer complete software stacks to provide mobile TV on mobile terminals. Its stack is available for Linux for embedded devices as well and supports OMA DRM (CyberLink 2007).
The Linux Kernel also offers device drivers for mobile TV chips such as the Siano SMS1000 (Siano 2007) or the DiBcom DIB7000-H (DiBcom 2007).
Already in 2005 the Siemens AG showed a Linux based concept device for mobile TV using DVB-H technique. It is based on the DiBcom DIB7000-H (LinuxDevices 2005).
It remains to be seen which standard will be the dominant and which will be usable in the Linux operating system. Many systems use the OMA DRM 2.0 that is already proven to work within a Linux environment. Other standards can be easily included into a software stack. It is up to the vendors if they will offer these stacks for the Linux operating system.

4 Influences on the Content Providers' Business Model

The content provider's biggest threat is of course that a user could overcome the DRM protection. This has already happened to a former version of Apple's FairPlay DRM as well as to Microsoft's Windows Media DRM. Companies like Napster offer so called "music flat rates". Their business model is based on the rent of music. After a subscriber cancels his/her subscription the downloaded media is no longer playable. So to say the whole business model of these companies is based on the proper functionality of DRM. Content provider will offer their content only as long as they know that the DRM protection can not be overcome easily. Therefore I think that content provider will select those technologies that have shown that they are hard to overcome. Another aspect is of course the market acceptance of the used DRM system. Most of the online music stores use the Microsoft Windows Media DRM. So it is most likely that the providers will support mainly devices with this technology.
On the last year's LinuxExpo Jeff Ayars, a vice president of RealNetworks, said that Linux success on the consumer market depends on its ability to support DRM (Marson 2006). Otherwise content provider will not offer their services for the operating system.

5 Terminal Vendor Strategies

Several examples for the successful convergence of Linux on mobile devices and DRM already exist. Motorola is an example with its Linux based mobile phones that are very successful mainly in the Chinese market. Linux has some important advantages in comparison to its competitors like Microsoft Windows CE and Symbian OS. Prof. Dr. Hermann Eul, executive vice president of Infinion Technologies, views Linux open architecture and reduced costs as the main advantages. Haavard Nord, CEO of Trolltech, states that Linux gives independence and control to the vendors. He is sure that Linux will emerge to a standard platform for smartphones (inside-handy 2005). As the major vendors of mobile terminals are working together in the OMA to establish a common DRM it is most likely that the OMA DRM will remain the main DRM system for mobile terminals for ringtones, pictures and MMS. But it will have more difficulties in the area of music, videos and broadcasting. The vendors depend on the content providers and the network providers. Microsoft's DRM and Apple's FairPlay are the dominant systems in the music market. Motorola is the first manufacturer to adopt the Microsoft DRM. Apple does not license its FairPlay to other companies so it is most unlikely that in the near future the system will be implemented in the Linux operating system.
As already mentioned before, ABI Research estimates that by 2012 203 million mobile phones with Linux will be delivered. It is up to the vendors to implement a stack including any DRM system from a third party company such as Trolltech or to implement their own approach. But it is more likely that the vendors will revert to third party products. The reason for this is the reputation of known companies. Content providers will only offer content for a certain system if they can trust the functionality and security of a system.

6. Conclusion

In this paper I pointed out that Linux is ready for the mobile market as well as DRM. I introduced several approaches how to implement DRM into the system: Tivoisation, OMA DRM and Microsoft Windows Media DRM. Because of its strong rear cover from the industry it is most likely that OMA DRM will remain the standard for the protection of content such as ringtones, graphics and MMS. Because of its heavy usage among the content providers and Microsoft's willingness to license I assume that the amount of devices with the capability to handle Windows Media

DRM encrypted files will increase. Whereas one also has to notice that there is a discussion about the abolition of DRM in the music market. Apple and EMI have announced that Apple will offer EMI's music catalog on its iTunes store without DRM protection (McCarthy 2007). As iTunes is the biggest online music store it is likely that other stores will follow their example. It is yet to be seen which standard will be used for mobile broadcasting. Most of the service purchase and protection frameworks are able to utilize OMA DRM 2.0 but also proprietary DRM techniques can be implemented in systems such as the Open Security Framework from the DVB-H group.

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MOBILE PAYMENTS

Petteri Tulikoura
Helsinki University of Technology, Telecommunications Software and Multimedia Laboratory
P.O. Box 5400, FIN-02015 TKK, Finland
petteri.tulikoura@tkk.fi

Abstract

Mobile payments could provide many benefits to everyday life of consumers as well as increase retailers' revenues. However, despite the wide media coverage about the benefits, not many mobile payment services have been launched. There are several different technologies as well as use cases for mobile payments but lack of cooperation between mobile payment market participants probably prevent the wider adoption of these services. This study identifies the main technologies, business models and point of views of the different market participants as well as provides an insight into future trends of mobile paying.

Key Words
Mobile payments, remote environment payments, local environment payments

1. Introduction

Mobile payments could bring many benefits to retailer in the form of faster processing times thus leading to shorted queues. Shorter queues can mean increased revenues as some sales in stores are lost because customers not wanting to wait to make a purchase (Choi et al., 2006). Merchants could also collect more information about their customers by introduction of these new technologies and hence strengthen the customer relationships. For consumers the mobile paying would provide a more convenient way of paying and efficient means of managing their cash balances.

Despite the many arguments about benefits that mobile payment systems could bring especially to consumers and retailers, the usage statics and advancement of technologies have been disappointing. Compared to the current payment system that includes credit cards, debit cards and checks, mobile payments would be faster, safer, more widely acceptable, less vulnerable to fraud and could also save cost and produce more profits in the long run (Choi et al., 2006).

It is an interesting question that if the benefits could be as mentioned above, why the mobile payment systems haven't emerged yet on a wider scale? The technology is already there on most parts. The objective of this study is hence to identify the main dimensions ruling the current mobile payment market and to investigate the motives of different market participants. A question about the main obstacles of the wider adoption of these systems is also addressed in this study.

The paper is organized as follows. The second chapter introduces the main players in the mobile payment market and discusses about their characteristics. The third chapter continues from this and presents the main technologies, business models and use cases of mobile payments. The Chapter 4 discusses about the future trends and the fifth chapter concludes and summarizes this study.

2. Actors in the Mobile Payment Market

Different actors in the mobile payment market participate in the service production at different levels and have their own motives, and sometimes hidden agendas, for a wider adaptation of mobile payment systems. It is thus worth briefly describing the main players in this market and discussing their role, possible benefits, motives and eagerness for adaptation. The players are divided to eight groups following Mallat (2006):

Consumers. The most important group in terms of the wider adaptation of mobile paying and the new technologies are the consumers. Their *role* is to act as the largest group of end users and the wider development of the market requires that consumers are willing to adopt these services to their everyday life. Mobile payment services could provide many *benefits* for consumers making their everyday life easier but so far service providers haven't been able to provide such services that would have *motivated* consumers. The wider *adaptation* will probably require more innovative service to catch up the interest of consumers.

Merchants. Merchants are another important adopter group for mobile payments and they are in a key *role* deciding which payment systems are offered for consumers as an option to pay on merchants' products and services. Although merchants can *benefit* from more innovative and convenient ways of settlement of the purchases, their *motivations* relies on the cost-benefit continuum. New technical payment services usually mean that the merchants have to adapt and maintain the new payment system needed to conduct mobile transactions and to train their personnel to consumer queries (Dewan & Chen, 2005). On the other hand, mobile payments have a faster processing time so the transaction time at the point of sale is also faster, leading to shorter queues in stores (Choi et al, 2006). In some industries, like in retail and transportation, merchants may even begin to offer their own concepts for consumer mobile payments (Ondrus & Pigneur, 2005). This means that merchants' *eagerness for adoption* of mobile payment services depends mostly on the economies of scale, i.e. they require enough wide adoption to meet their target level cost-benefit ratio.

Network service providers. Network service providers' *role* is to provide the infrastructure for mobile payment transmissions. While this role has been traditionally assigned to mobile network providers, also other network providers for remote and proximity connections may provide the required infrastructure. Network providers' *benefits* are mainly in collecting transmission fees on the network usage so their *motivations* most probably are in the *wider adoption* of mobile payments.

Financial institutions. Financial institutions *role* is mainly in mobile payment transaction clearing and settlement or they can provide their own mobile payment services for customers (Kreyer et al., 2003). In instances where banks are involved, there are usually two banks to facilitate the clearing and settlement of the transactions: the issuing bank, maintaining the consumer's bank account information, and the acquiring bank, who acts as the representative of merchant's account information (Dewan & Chen, 2005).

Device manufactures. Device manufactures hold an important *role* in the mobile payment value chain as they control and are responsible for the technology and functionalities of end-user devices and which are needed in mobile payment transactions (Karnouskos, 2004b). Wallet applications, RFID chips, and NFC technology are examples of these emerging mobile payment technologies in the handsets. Manufactures certainly would *benefit* from the *wider adoption* in the form of increased handset sales but different manufacturers' *motives* can be in developing their own standards. Manufacturers' decisions about the mobile handset features are mainly market demand driven so they don't such high incentives for promoting wider adoption.

Technology providers and software houses. The role of these actors is to provide technology for mobile payment, such as software, hardware, integration platforms, and other technological components that facilitate mobile payment transactions. Like device manufactures, these market participants also *benefit* from the *wider adoption* through increased revenues. Their *motives* certainly will be in developing innovative mobile payment solutions.

Government and central banks. Government role is in setting legislation and regulation and which may impose constraints under which mobile payment systems are developed, introduced, and used (Karnouskos, 2004b). National banking systems can *benefit* from more efficient payment mechanism so governments and central banks *motives* can be in promoting *adoption* of these systems.

Payment service providers. This group forms the very core for the mobile payments and different players in the mobile payment market may assume the role of a payment service provider. Currently, the most common providers are mobile (virtual) network operators, banks, new startup companies or established industries such as public transportation operators or retail chains. *Mobile operators* have an access to large customer base and they also already control these customers micro-payment and billing infrastructure. These operators, however, have limited experience in payment systems in larger scale and are less capable of handling the risks associated to the payment mechanisms. Financial institutions are better positioned to provide stability to the mobile payment infrastructure as they have a strong established position as trusted payment mechanism providers among both the merchants and consumers. Financial institutions current systems are not yet, however, sufficient for micropayments and they thus probably need cooperation with other market participants. *New startup companies* are probably among the most innovative but lack the existing infrastructure and customer base.

As Choi et al. (2006) present, all these players have to cooperate for the mobile payment services to succeed and they have to follow a wide range of criteria to keep the services working. Each interest group has to be open-minded and cannot look only at the business or technical aspects. They have to be willing to look at the economic aspects of the process and to develop technologies and models to keep the framework a continuing success.

Players in the mobile payment market have different expectations for the system, the customers being in the center (Karnouskos, 2004b):

Customers expect *simplicity and usability* before they are ready to adopt the technologies.

Universality is another expectation to be fulfilled so that merchants and service providers can appeal to more customers.

Interoperability is a third expectation as the issue has been important topic on the financial services sector as standardization and interconnection of networks and systems bring cost efficiency.

An important expectation is also the *security, trust, and privacy* issue as to payment methods to work the users must trust the mobile payments system.

Cross-border payments are also expected to be almost as easy as local payments.

The systems should *save cost and increase speed* to provide the service providers benefits and to make end-users more satisfied.

And the mobile payment system is expected to have local market understanding as customers have to be persuaded about the benefits of new methods.

3. Mobile Payments Service Cases and Technologies

Mobile payments can be implemented in both electronic and physical environments, and which can be categorized as remote or local in respect to the distance between the payer and payee (Ding & Hampe, 2003; Kreyer et al., 2003). Different environments of mobile payments can also be based on different mobile payment models depending on the parties involved in and responsible for the transaction and communicating with the mobile device. This chapter describes use environments and typical payment models in mobile payment services as well as presents the typical technologies and systems.

3.1 Remote Environment

Remote environment mobile payment means purchase of products or services that are accessed through remote channels like the Internet, cellular networks, television, or mail-order catalogues (Mallat, 2006). Majority of the mobile payment transactions today are micro-payments and through mobile channels and are processed in mobile operator networks and billing systems (Ding & Hampe, 2003). Remote environment mobile payment purchases include mobile services and content such as ringtones, logos, news, tickets, location information, horoscopes, and picture messages (Mallet, 2006). Furthermore, remote environment mobile payments are particularly interesting on the Internet where charging for micro-payments is problematic and to which the new payment mechanism could potential provide a solution. Mobile payment system offers also an alternative payment channel for mail-orders, TV-shops and Digital TV (Mallat, 2006).

3.2 Local Environment

Local environment mobile payments can be used for purchases at a physical point-of-sale location such as near to a vending machine or in shops, stores, kiosks, public transportation, and taxis (Mallat, 2006). As Begonha et al. (2002) identify, mobile payments cannot currently compete directly with existing card payments, mobile payments can provide a convenient alternative to cash and could work especially well in unmanned checkout points. The authors also argue that mobile payment mechanism could be established especially well in markets with low card penetration but with high mobile phone penetration.

3.3 Mobile Payment Models

As some authors argue (see e.g. Fouskas et al., 2005; Wang & Wang, 2005), there are only a few payment models widely used in mobile payment services.

In the **acquirer-centric model** the merchant and its agent are in charge of communicating and interacting with the customer's mobile device (Karnouskos, 2004b).

In the **issuer-centric model**, in contrast, the customer and his agent are in the responsibility of handling the interaction with the mobile device whereas the merchant can be totally uninformed about the technical nature of the transaction (Karnouskos, 2004b).

Bank handles the mobile payments in the **bank-centric model** and banks are also more experienced of completing all kinds of payment transactions. Mobile operators, on the other hand, are new to the financial aspect of mobile services as they are only used to billing the customers for the mobile operator's services. In the bank-centric model operators provide only the network to between the customers and bank, hence leaving the transaction handling to banks. Benefits from this model are that the payment is drafted immediately from the customer's bank account and this is more convenient for the customers as the method utilizes their existing bank account and hence do not require any additional paperwork (Choi et al., 2006; Herzberg, 2003).

3.4 Mobile Payment Technologies

Mobile payment systems can facilitate different technologies depending on the choice of use environment, local or remote (Mallat, 2006). In the case of remote payments a connection through the Internet and/or a mobile data transmission network is required. Remote environment use cases thus currently facilitate mostly the 3G and GSM networks.

In local environments, for example Bluetooth, infrared, WLAN or contactless RFID chips embedded in mobile phones can facilitate the needed data transmission (Ding & Hampe, 2003; Chen & Adams, 2004; Zmijewska, 2005). New proximity technologies, such as contactless RFID, are gaining popularity in usage and experiment of point-of-sale payments and are expected to facilitate the emergence of these payment systems (Balaban, 2005).

Currently, mobile payments are commonly conducted at the user application end by calling or sending an SMS to a premium rate service number or by accepting a receipt of a charge-back SMS (Mallat, 2006). This applies currently to both environments, to the local and the remote. Moreover, WAP phones also allow customers to use the phone's micro browser to send a service request to a merchant's mobile Internet site and hence the user can avoid typing an SMS (Mallat, 2006).

The future of local environment payment systems is however, at least as the current prediction of many academics, in the new mobile RFID technologies which require the user to place or wave the mobile device in the front of a reader and possibly to acknowledge the payment with a keystroke (Mallat, 2006).

All the abovementioned technologies can be categorized according the point of time when the customer is charged from their purchase and it is the topic of the next section.

3.5 Mobile Payment Systems

Mobile payment systems can be grouped into prepaid, real-time and postpaid systems depending on the point of time when the payments are charged from the customer (Karnouskos, 2004b; Kreyer et al., 2003). There are also different risks as well as opportunities for different parties in mobile payment transactions and payments can be categorized into different levels depending on the size of the transactions. This section first introduces the time issue and then discusses about the different characteristics related to the nature of transactions.

Pre-paid mobile payment systems payments are credited before the payment transaction taking actually place. The pre-paid payment model can also be categorized into three alternative subgroups of systems:

1. Telecom operator's pre-paid subscription customers who use their **pre-paid "air time"** to pay the purchases.
2. Pre-paid **mobile wallet** used as a separate mobile payment account, to which users transfer money and which is then debited after each purchase. The mobile wallet can be provided by a merchant, a telecom operator, a bank, or some other mobile payment service provider.
3. Mobile **RFID** through embedded contactless RFID chip within a mobile phone (Funk, 2004) which can be used to load credits and then used to pay purchases.

Real-time systems embed a transfer of payments from the payer to payee during the transaction. An alternative for the real-time mobile payment system is the mobile direct debit, which is similar to the traditional debit card payment. The mobile debit system is connected to a customer's debit card or the customer's bank account is debited directly during the purchase transaction.

Post-paid transactions, on the other hand, are credited some time after the purchase transaction taking place. These post-paid mobile payment solutions comprise of different types of billing schemes:

- Mobile credit systems are connected directly to the user's normal credit card system and the purchases are added to the credit card bill of the customer.
- Mobile phone bill is another, and currently popular, way to charge for mobile payments. This relies on the billing systems of mobile operators and do not require any additional registration or account management form the customer's part (Peirce & O'Mahony, 1999). But as discussed in the chapter 2, mobile operators are usually without sufficient financial transaction experience and capabilities.

Mobile payment systems also differ in dimensions like who carries the risk or benefits on the opportunities related to the timing of funds transferred (Mallat, 2006).

Pre-paid systems, for instance, reduce the credit risks associated to the mobile payment service providers' as the payment from the payer is already credited in advance.

In pre-paid systems the service provider is also able of taking the advantage of the funds that have been paid in advance as money have always a time value.

In contrast, in the post-paid systems the money time value advantage goes to the payer. However, there are many people who are concerned about controlling their spending and prefer the more timely charging models (Szmigin & Foxall, 1999).

Another issue characterizing different types of mobile payment systems is the transaction value enabled by the system. The transaction value is in importance as different mobile payment market participants have different level of capabilities, as described in the Chapter 2, to manage financial issues, access to customer base, and access to technologies and infrastructure needed. The transaction sizes pose different needs and requirements for payment system design and implementation (Mallat, 2006). For example, Kreyer et al. (2003) categories the sizes of payments to four groups:

- Pico-payments (<10 cents)
- Micropayments (10 cents – 5$)
- Lower macropayments (5 – 50$)
- Higher macropayments (>50$)

The transaction size matters as for example for micro-payments the transaction costs need to lie in the range of 10 cents in less than $1 transactions to the transactions to be economically viable (Hinds, 2004). For larger macro payments the security and trust issues become important and hence require more secure payment processing and trust building between the transaction participants (Mallat, 2006).

Hence, all the issues discussed in the Chapter 2 about mobile payment market participants and their motives as well as the issues discussed here in the Chapter 3 about the characteristics of service cases and technologies, form a set of requirements and challenges that have to be overcome. The everyday usage of mobile payments is still low although many benefits of mobile paying have received a lot of media visibility recently. Thus, the objective of the next chapter is to provide discussion about the obstacles to be overcome and future trends on the field of mobile payment systems.

4. Future of Mobile Payments

This chapter first introduces the main obstacles for a wider adoption of mobile payment systems and the second section discusses about the future trends.

4.1 Current Obstacles to Overcome

As Choi et al. (2006) argue, there are still many barriers for mobile payments to become instituted to the public's everyday use. The first of these barriers is the lack of alliances between banks and mobile network operators. Currently, many payment associations prevent banks from placing their payment applications on platforms that are non-bank issued, the mobile operator controlled SIM cards being an example of these (Karnouskos, 2004b). The emergence of mobile payment systems also requires that different market participants have to create trusted alliances that bring security to mobile transactions. Therefore, a full alliance between both, the mobile network operators and banks, would have a significant effect on the adoption of these services allowing merchants and customers to transact with each other. Related to these alliances is also the fact that while banks concentrate mostly on micro and macro payments, the mobile network operators' concentration is on micro and pico-payments. And to handle macro payments, mobile operators would have to apply a banking license in many countries (Choi et al, 2006).

Another important barrier to be solved in the future is the privacy issue. Mobile payment companies collect private information about their clients and which is then stored in data centers and distributed all over the world to facilitate seamlessness payment mechanism. This also leads to increased number of access points to the data because of the need for partial shared information to all collaborating parties, and privacy is rarely addressed in these settings (Choi et al., 2006).

4.2 Future of Mobile Payment Systems

Mobile payments are still a new technology and are just waiting to be utilized fully to everyday use but there is much room for improvement on technological solutions and security issues.

The majority of the current technological solutions are focused on 2G and 2.5G infrastructures whereas only a few of the approaches have been tested on technologies such as UMTS, WLAN, WiMAX (Choi et al., 2006). These technologies could free the mobile payment systems from the current limitations like the privacy issue.

Moreover, as device manufactures keep on introducing new sophisticated technologies to new sold mobile phones, the idea of advanced cryptographic services will be integrated into these devices and thus enable enough high security level for privacy (Choi et al., 2006). There are also other security technologies expected to become available in the future like MobilePKI, mobile digital signatures, encryption and biometric authentication.

5. Conclusions

None of the mobile payment market participants probably do have enough high incentives to push for the wider adoption of mobile payment technologies alone and the task probably wouldn't even be possible for a single party. Mobile device manufacturers are not willing to introduce new sophisticated features and technologies to handsets without a clear demand from the customer side. Customers, on the other hand, are not willing to adopt the new payments mechanism without the privacy and security issues solved and without sufficient technology. Mobile payment service providers cannot introduce advanced security solutions without technologically capable platforms. Small independent mobile payment service providers cannot either make any major moves to facilitate a larger adoption of theses systems as they do not have the access neither to the customer base nor the financial resources. Banks and mobile network operators haven't formed the needed alliances to speed the adoption process and there are many barriers to be solved between these participants. Merchants are probably willing to adopt these systems as mobile payments could increase their revenues but they neither are alone capable of making the change.

Hence, collaboration is needed between the market participants to facilitate the change. The change will probably take place first in countries where collaboration between these stakeholders is already on strong grounds and culture is towards innovation. An example of these kinds of countries is Japan where some innovative mobile payments services have already been introduced. Japanese corporate system has long time been bank-centric and strong relationships between banks and larger corporations already exist. Thus, Japan probably will be the forefront for wider adoption and development of innovative mobile payment services. Experiences and proven business models from countries like Japan can convince the mobile payment market participants also in other countries to put a common effort to facilitate the change. The prevailing uncertainty in many countries about market demand for mobile payment services and who will be responsible for making the largest investments in the payment infrastructure are probably the biggest obstacles for the wider adoption. Positive experiences from other countries or perhaps even a governmental intervention could increase the pace at which these new services will be introduced for the public.

Mobile payment services probably will be provided for consumers in the future but at different paces at different countries. The change most probably will begin from Japan and other countries will eventually follow when the infrastructure and market demand is ready.

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MOBILE VIDEOPHONE

Lauri Mäkinen
Helsinki University of Technology
Networking Laboratory
P.O. Box 3000, FIN-02015 TKK, FINLAND
lauri.makinen@tkk.fi

Abstract

Video telephony in fixed networks has an uninspiring history. The service has struggled with issues such as quality, cost and low consumer interest. With the advent of 3rd generation mobile networks the service has re-emerged. With mobile videophone service telecom operators are hoping to drive the adoption of 3G networks and services; aiming for a more feature-rich service. With 3G video telephony has finally reached technological maturity; whether it will become a mass phenomenon is still unclear.

Key Words
3G, mobile videophone, business, 3G-324M

Introduction

In the early years of the public telephone service, transmitting a live picture of the person one is talking with seemed like the next natural evolutionary step. Even the inventor of the telephone, Alexander Graham Bell, has been quoted of saying "the day would come when the man at the telephone would be able to see the distant person to whom he was speaking" (Schaars, 2004).

Since the 1960s there have been numerous attempts to create a product of this concept of videophone. All of these attempts have followed a similar disappointing pattern of overly optimistic expectations, lackluster demand and eventual withdrawal from the market.

Several approaches to commercialization have been attempted, ranging from high quality and high cost products to low quality and moderate price.

With the advent of third generation mobile telephone networks (3G), a technological maturity has been reached to provide a mobile videophone service at a modest price.

The purpose of this paper is to provide an overview of the related technical issues – namely the 3G mobile videophone protocol suite called 3G-324M – and of the mobile videophone as a service. The success factors and weaknesses are also explored and contrasted with past failures.

Videophones in Fixed Networks

For most of its history, the development efforts for the videophone have been driven by one company, AT&T. The teleostereograph – developed by AT&T in the 1920s – can be seen as a forerunner to videophone. The teleostereograph was essentially an early version of fax, enabling the sending of still pictures over telephonelines. It was succeeded by the first videophone published in 1927. The contraption took up half a room, delivering a moving picture at 18 frames per second (Schaars, 2004).

Despite the interest received by the first videophone, it took the videophone almost four decades to evolve into a commercially available product. Over time several approaches to capitalizing on the concept of videophone have been attempted.

Video calling booths
In 1964, AT&T published the first public videophone service. The service was based on their Picturephone I product. Picturephones were placed in booths in three major cities in USA; New York, Washington and Chicago. The users had to book a time to use the videophone booth. A three minute videophone call cost $16. To boost demand AT&T cut prices and relocated the booths. After four years of anemic interest, the service was discontinued.

The video calling booths turned to be too much of hassle to use – scheduling a session was tedious. Also the cost was simply too high.

Desktop Videophones
After the failure with videophone booths, AT&T focused on their business customers. In 1965, 35 executives at Union Carbide in Chicago and New York were given Picturephone I sets for test use. Businesses were obvious potential customers since they were the only ones with the resources to pay for the bandwidth required for videophone calls. A three minute long-distance videophone call cost $13.50, around ten times as much a voice call.

In 1967, the second generation of videophones, the Picturephone II was introduced. This was a relatively incremental improvement on the first model. Picturephone II was just as data-hungry as its predecessor, requiring several regular telephone lines to operate. It featured a larger display, a possibility for multiparty videoconferencing and document faxing.

The desktop version of videophone saw a low number of users with a high churn rate and by the mid-1970s the service had virtually ended. The Picturephone was clearly ahead of its time, the stride for high quality of service made it ultimately too expensive (production costs estimated at $1500). High cost coupled with economic recession of the early 1970s made it impossible for the service to gain a critical mass of users. Also the Picturephone service did not fulfill a consumer need – it added very little to an ordinary voice call.

Videoconferencing
During the 1970s AT&T's Picturephones morphed into what is known as Picturephone Meeting Service (PMS). Essentially the service was a form of videoconferencing, which was aimed to replace traveling to meetings. The customers could either rent a room with a PMS setup to have a meeting or have one installed for them. Being targeted for businesses the cost of the service was quite high, a transcontinental one-hour meeting in a public PMS room cost $2340. The cost of owning one was higher, $117 500 for initial setup and additional fees for actually using the service. Once again interest fizzled and by 1990 the service was discontinued.

Videophones for the masses
In the 1980s, the Japanese consumer electronic companies attempted a wholly different approach to videophone. Their aim was to realize a videophone service using the existing telephone system, which made the entire service a lot cheaper. Mitsubishi entered the market in 1986 with a $1450 Luma 1000 and followed a year later with Visitel priced remarkably low at $400.

Despite high expectations the Japanese videophone failed to take off. Although the price was affordable, the picture quality was poor – 16 shades of grey at low resolution and frame-rate.

In 1992 AT&T published its version of the videophone using ordinary telephone lines called VideoPhone 2500. It employed video compression techniques to eliminate redundancy and featured color. The calls made cost as much as regular voice calls; still it failed to attract enough paying customers.

Reasons for failure in fixed networks
Although video telephone captured the public's imagination, this interest failed to be manifest as commercial success. There are a few core reasons to this. Firstly the videophone didn't satisfy a consumer need; there was always a major technological push, but no real pull from the market side. Not responding to a real need, the videophone was simply too expensive as a novelty item. The network effect also played a part; nobody was willing to buy a videophone if there was no-one to call. Additionally, the right balance between cost and quality was not found.

3G Mobile Videophone

Despite difficulties in fixed networks, the subject of videophone re-emerged with the advent of 3G mobile networks. It became clear early on that 3G – which was originally planned to be an all-IP solution – couldn't provide a sufficient videophone service as such. Therefore the mobile videophone in 3G was implemented using a circuit-switched method. The 3G mobile videophone is based on the ITU-T standard H.324. The H.324 standard is an umbrella recommendation for video telephony in the public switched telephone network (PSTN). The standard is comprised of several components, which include a multiplexing protocol (H.223), a V.34 modem, a call control system (H.245), codes for audio and video, optional data protocol and optional encryption support (3GPP, 1999), (Orr, 2003).

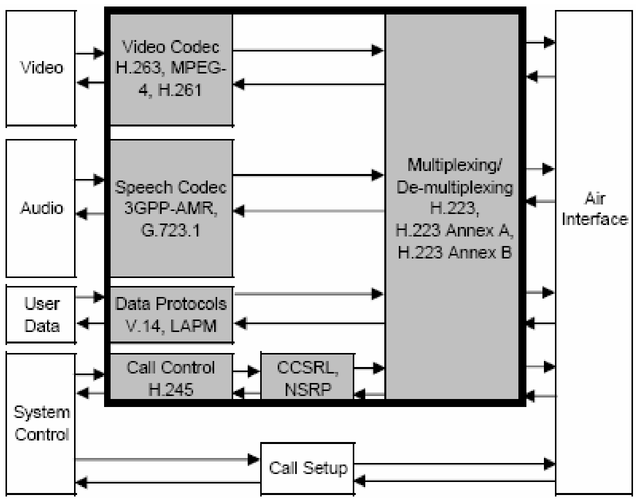
3G-324M is in a sense a reinforced version of H.324; it adds error resilience features required for communication over an unreliable air interface. The most important difference is that in 3G-324M some optional features of H.324 have been made mandatory. These features include H.263 for video coding, annexes A and B for the H.223 multiplexing protocol and the AMR codec for audio.

3G-324M is supported by the two major standardization organizations: 3GPP (supporting UMTS technology) and 3GPP2 (supporting CDMA2000). This ensures interoperability, which is vital in such a heavily networked application. Interoperability with VoIP systems is also possible through the use of gateways (Orr, 2003), (RADVISION, 2007).

3G-324M

The standard for mobile video telephony in 3G networks is 3G-324M. It is an adaptation of H.324 which targeted for fixed networks. The 3G-324M is comprised of several subprotocols all providing different functionality (3GPP, 1999), (Orr, 2003).

Figure 1: 3G-324M Standard Architecture



H.223 Multiplexing/De-multiplexing protocol
The H.223 protocol handles multiplexing/de-multiplexing of several data streams such as speech, video, user data and bearer control. Different streams are handled with Adaptation Layers (ALs) (ITU-T H.223, 2001).

• **AL1** is for user data bearer control messages (H.245). It relies upon upper layer protocols to provide error control.

• **AL2** is the preferred layer for speech. It provides an 8-bit CRC (cyclic redundancy check) for error detection and optional sequence numbering for loss detection.

• **AL3** is the preferred layer for video. It too provides error detection (16-bit CRC) and sequence numbering. Additionally it also provides ARQ (automatic repeat request) for retransmission.

The H.223 is also divided into levels according to robustness and error resilience they provide.

• **Level 0** is the H.223 baseline. It uses 8-bit HDLC synchronization flags and bit-stuffing avoid flag emulation in payload data.

• **Level 1** (defined in Annex A) is designed for communication over low error-prone channels. It improves over level 0 by replacing the 8-bit synchronization flags and stuff bits with 16-bit pseudorandom noise as delimiters, to improve error resilience.

• **Level 2** (defined in Annex B) is for communication over moderate error-prone channels. It adds payload length information and FEC (forward error correction) information to the headers.

H.245 for Call Control
After multiplexing-level synchronization has been established the first logical channel is opened for call control, which uses the H.245 protocol. H.245 is aimed at non-telephone related control functions, which include:
Master-slave determination: Since H.245 is asymmetric, a master-slave relationship between two parties has to be established, master being responsible for decision making in conflict situations.
Capability exchange: In order to communicate the two parties must reconcile on the codecs etc. to be employed. The two peers share their capability information which includes mode of multiplexing, audio and video codecs, data sharing modes etc.
Logical channel signaling: Procedures such as opening and closing media transmission channels are handled with logical channel signaling.
Multiplex table management: This allows the addition and deletion of multiplex table entries.
Mode request: Usually the transmitter decides mode parameters such as the video codec to be used; with mode request the receiver may request a mode to be used.
Round-trip delay measurement: This enables quality characteristics measurement.

In addition to these, H.245 provides miscellaneous call control commands and indications.

Video encoding: H.263
The 3G-324M states that the H.263 video codec is a mandatory feature. It is now considered somewhat of legacy codec. It doesn’t provide any error recovery or resilience as is.

Video encoding: MPEG-4
MPEG-4 is a suite of video codecs and related standards for many different purposes. In the context of 3G-324M MPEG-4 refers to MPEG-4 Part 2 (ISO/IEC 14496-2) also known MPEG-4 Visual. It is in fact an optional part of 3G-324M. The standard states that when supported, the Visual codec version to be used is the Simple profile at level 0. The profile defines the subset of the toolset of Visual to be used and levels are related computational complexity.

MPEG-4 Visual Simple profile at level 0 provides error resilience and concealment through techniques such as Data Partitioning (DP), Reversible Variable Length Coding (RVLC), Resynchronization Marker and header extension code. The Visual Simple profile allows input formats such as CIF (352x288 pixels) and QCIF (176x144 pixels) (also used by H.263). The Visual codec is baseline compatible with H.263.

Success Factors

The potential success factors for mobile video telephony and videoconferencing are such that might make them successful unlike their predecessors.

Probably the single most important success factor for the mobile videophone, in contrast to its predecessors, is the fact that it is not a stand-alone product (Schaars, 2004). This means that no additional investment (e.g. hardware) from the user is required to enable it. It is marketed as just one service in the spectrum of services enabled by 3G. Mobile video telephony is also able leverage the synergy gained from other 3G streaming multimedia applications (such as video-on-demand) (Dilithium Networks, 2005).

As mentioned before, the 3G-324M is widely embraced, making interoperation easy. Also interoperation with VoIP systems is possible. This is vital to the success of the standard and therefore mobile telephony (RADVISION Ltd., 2007).

User Perspective

Mobile video telephony provides exciting possibilities for the end user. It provides a new channel to convey emotions remotely in personal communication. In addition to being utilized in a “see-me” manner, it may

– perhaps more interestingly, thanks to the mobile element – be used in a “see-what-I-see” style. This may be seen as one more way 3G technology allows users to share experiences (Dilithium Networks, 2005).

Using a mobile videophone call requires a lot more from a user than a regular voice call. The user has to concentrate on aiming the camera, increasing the cognitive load and placing the user in a less comfortable pose. This eliminates the use of a videophone in situations when the user is preoccupied with other (physical or mental) activities. Also there are times when the user simply does not wish to be seen. Moreover the use of video makes mobile communication less discrete (Filigheddu, 2006).

In Finland mobile videophone call are priced at around 0.20€ per minute, making them quite expensive compared to regular voice calls. On the other hand video calls are offered as a normal feature of the subscription, thus no separate opening fee is charged (TeliaSonera Oyj Finland, 2007), (Elisa Oyj, 2007).

Conclusions

Video telephony is an interesting service in the 3G offering. As mobile operators are desperate to drive the adoption of their newly built 3G networks and their services, video telephony is hoped to be seen by consumers as one of many exciting new multimedia based services offered by 3G.

Table 1: SWOT Diagram of Mobile Videophone as a Technology and as a Service

Strengths • one standard embraced by all • interoperability • satisfactory quality	**Weaknesses** • satisfactory quality • awkward user experience
Opportunities • ever increasing bandwidth • declining popularity of flight travel • ever increasing bandwidth	**Threats** • the network effect • no real use need • price competition

The question of whether mobile video telephony will become a technology that is going to enjoy widespread popularity is closely coupled with the question of the future acceptance of video telephony in general. It is possible that video telephony is going to become a widely accepted alternative to travel, especially among businesses.

This is due to related technology finally becoming of age, but also due to flight travel possibly becoming less popular. There are two major reasons behind this; the first one is that the terrorist attacks of September 11th and alike have forced the airline to tighten security measures, which has made flight travel increasingly cumbersome (Schaars, 2004).

Another reason for flight travel becoming less attractive in the future is the increased awareness of the effects it has on the environment. This might lead to people voluntarily avoiding air travel and on the other hand to legislative action aiming hinder the negative environmental effects, which might in turn lead to raised ticket prices due to taxation.

The need for video telephony as a replacement for face-to-face meetings is likely to be even stronger in the future. The growth of outsourcing and geographically dispersed teams within companies calls for efficient means of communication.

It is unlikely that mobile video telephony will ever compete in popularity with the traditional voice-only telephone service. Therefore it shouldn’t be viewed as “a better telephone service”, rather than a complementary service.

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APPROACHES TO HOME CONNECTIVITY

Marko Berg
Helsinki University of Technology
Telecommunications Software and Multimedia Laboratory
marko.berg@iki.fi

Abstract

A plethora of digital devices exists for work, entertainment and communication at home. Several of the activities in these categories benefit from, or even require, the use of the same content or services on several devices. Today, most such cases require complex configuration of device-specific settings related to e.g. networking, content types and access settings. This paper presents some of the most popular technologies that could alleviate, or eventually solve, this problem. Two of these, originating from the Universal Plug and Play (UPnP) Forum and the Digital Living Network Alliance (DLNA), clearly dominate the market when measured with the number of supporting devices. While both offer viable solutions in their respective target areas, seems DLNA to be a more likely candidate to provide true home connectivity.

Key Words
Home connectivity, UPnP, DLNA

1. Introduction

The increasing speed of technological innovation is pushing more and more of its applications to homes. These applications come in the form of a proliferation of devices. While the final uses of those appliances can be thought of as traditional, new innovations and a quickly growing demand for better service quality rapidly provide new and interesting solutions.

The traditional uses of home appliances can be seen, in the context of recent home technology device innovations, as watching videos or still images, listening to music and other audio material, and communicating using both of these media. These services have in some form been available for quite a while and consumers have grown used to them. However, recent developments in the performance of the used technologies and in the sophistication of the solutions is providing consumers with more and more choices on how, where and when to use these services. Devices for viewing video and images provide better image quality, and audio systems with ever more channels do the same for voice services. Improvements in communication and data transfer systems have resulted in more bandwidth being available with smaller devices than before, which makes it possible to mobilize the traditional services and detach them from any particular location. Some of the resulting scenarios are presented below. To add to the mix, new ways of acquiring and producing service content emerge constantly. Handheld computers and mobile phones are integrated with digital video recording capabilities, and digital cameras for both video and still images are widely available. Content can be downloaded in several forms, and over the public network or from a local one, as well as received from broadcast systems, such as the traditional television network. And finally, even the most traditional media for acquiring content are becoming multifaceted – a non-trivial example of which is the introduction of digital transmission to the television network.

As can be predicted, this turmoil of devices and technologies offers a wide range of new and exciting application areas, but also presents significant challenges on the control of the chaos. While technological solutions exist for solving most, if not all, of the problems related to e.g. content management, data transfer, device intercommunication and service mobility, that is not enough. In order to provide attractive services to consumers, devices from different manufacturers need to interoperate, so the selection of technologies as a solution to a common scenario needs to be coordinated. An important, related issue is the focus on end-user experience – without this concern, the consequence of new, innovative products might be frustration instead of awe on the part of the consumer. If the increasing number of technologies shows as such to the end-user - as a jungle of configuration options and technical jargon - the utopia of a digital home might be unlikely to realize.

Standardization is required for interoperability between manufacturers, and a major concern in the process is the end-user experience that these standards facilitate. Support for interoperability is only theoretical if achieving it requires complex configuration and knowledge of the underlying technologies on the part of the consumer. The autonomous configuration of device networking in the home environment, in a user-friendly way, is referred to as home connectivity. This paper first presents situations where some of the most common forms of interoperability are required. It then overviews current solutions for home connectivity, and presents two, in part complementary, solutions in more detail – the UPnP standards and the guidelines provided by the DLNA. The current role of these solutions in home connectivity is then discussed. Finally, conclusions regarding the potential of these solutions are presented and the factors necessary for commercial success are considered. Issues related but external to connectivity, such as content management, digital rights management and security are outside of the scope of this document.

2. Home Connectivity Use Cases

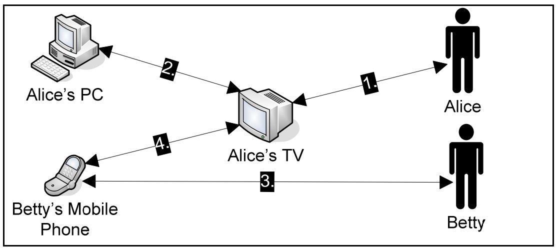
Home connectivity provides, or more accurately would provide, significant value to device manufacturers in the form of new functions for the basic devices through automatic compatibility (Shapiro 1999). A consumer does not want to buy a usage scenario - one has to emerge with the existing devices at home. The consumer is very unlikely to hear of an attractive usage scenario, walk into a store and order all the required equipment from a single vendor. With compatible devices, the usage scenarios emerge once the devices configure themselves, and the services are right away available to the consumer. Once consumers get used to this idea of home connectivity, compatibility may also become a significant sales argument. This is unlikely to take place if device vendors use proprietary solutions for home connectivity, since single-branded environments are likely not common enough at homes.

This chapter presents three use case scenarios that can utilize commonly needed home connectivity features. Such features include e.g. a communication channel between devices connected to fixed and mobile networks, the ability of a device to locate a service in its current network, and conversion capability between media formats optimized for different devices. The scenarios do not relate to any specific protocol or technology, but illustrate the types of services provided by home connectivity. Use case scenarios presented here are aggregated from (Miller et al. 2001) and (DLNA Use Case Scenarios 2007).

2.1 Image Display from Multiple Sources

Figure 1 illustrates a use case of image sharing and display. Betty has come to visit Alice, and Alice decides to show some family photos to Betty. Alice turns her television set on, and opens a list of image sources (Step 1). She chooses her home PC as the image source, and tells the television set to display the images from that source (Step 2). After having watched the images, Betty remembers she has some new photos in her mobile phone that she wants Alice to see. She tells her phone to look for devices capable of displaying the images, and finds Alice's TV (Step 3). She then tells her phone to send the images to the TV for display (Step 4).

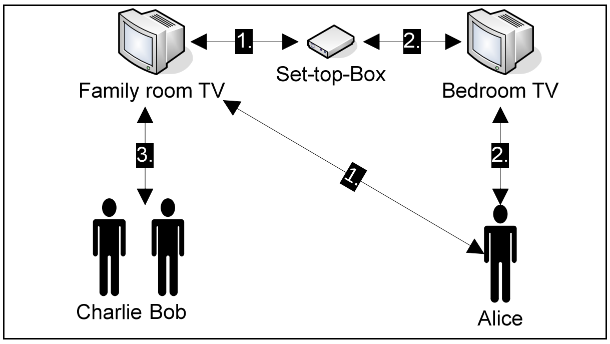
Figure 1: Image Sharing Use Case



2.2 Video Service Mobility

A scenario for video service mobility is shown in Figure 2 below:

Figure 2: Video Service Mobility Use Case

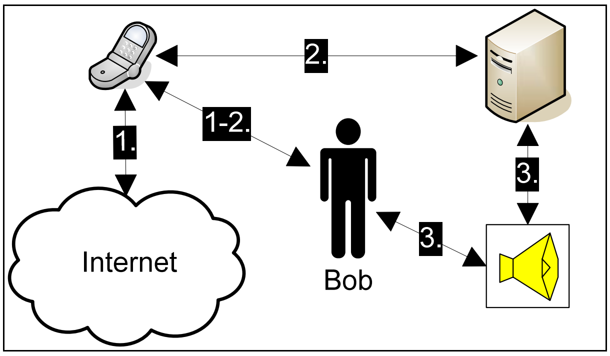


In Step 1 Alice is sitting in the family room and watching a TV show she saved earlier on the set-top-box (STB). Her husband Bob arrives home with his friend Charlie to watch a football game. Alice thinks the family room TV is best suited for watching the game, and stops the TV show. She moves to the bedroom and turns on the bedroom TV. Alice tells the TV to show a list of the saved programs, and chooses the show she was watching earlier, continuing from where she left off (Step 2). Bob and Charlie can now watch the game in the family room (Step 3).

2.3 Central Media Source

Bob is sitting in a bus on his way home from work, and uses his mobile phone to purchase music from the Internet (Step 1). He listens to a song and likes it, and decides to store it once he gets home. He uses the phone to store the song on the home media server (Step 2). Later in the evening, Bob is working in the hobby room, and wants to listen to the new song again. He turns the hobby room audio system on, and tells it to list audio sources available. He finds the new song on the media server and plays it (Step 3).

Figure 3: Central Media Server



3. Technologies for Home Connectivity

This chapter overviews current solutions for home connectivity. Two of these, UPnP and DLNA guidelines, are then presented in more detail.

3.1 Technologies for Home Connectivity

Zeroconf in the home connectivity context originally referred to an IETF (Internet Engineering Task Force) working group (WG) that was formed to define requirements for zero configuration networking (Zero Configuration Networking 2007). The group was established in 1999 and completed its work in 2003. After that the term “zeroconf” has in some contexts been adopted more widely to mean virtually any autonomous configuration mechanism independent of technology. In this paper, however, Zeroconf refers to the IETF WG specification (Williams 2002).

Bonjour, formerly known as Rendezvous, is a solution for device and service discovery in IP networks (Steinberg 2005). Bonjour is developed by Apple, and is the most notable implementation of IETF’s Zeroconf specifications. Zeroconf, and thus Bonjour, build mostly on the PC networking technologies, and offer no specific solutions for more general home connectivity issues. Device and service discovery could of course be used on consumer electronics (CE) and mobile devices, too, but in general issues relevant to the home connectivity use cases are not addressed in Bonjour. Other open source implementations of the Zeroconf specification include Howl and Avahi (Steinberg 2005).

Jini is a network-centric, protocol-independent specification in the Java language developed by Sun Microsystems (Jini Network Technology 2007). Jini provides a lot of features needed in the home connectivity environment, such as a service lookup capability, a security model, transaction management and an event system. Language dependency is of course a major limitation of implementation for many device types in the home. The architecture also requires centralized services, i.e. a lookup server, which somewhat contradicts the concept of zero configuration (Jini Technology Architectural Overview 1999).

3.2 Universal Plug and Play

This chapter introduces UPnP in more detail and is mostly based on the work of Miller, Nixon, Tai and Wood (Miller et al. 2001).

UPnP is developed by the UPnP Forum, established in 1999. UPnP Forum has in June 2007 over 800 members (UPnP Membership List 2007), from fields ranging from consumer electronics to software corporations and semiconductor companies - including most of the largest players in each field. UPnP was designed as an interoperable machine-to-machine protocol for device vendors to enable hiding the discovery and control configuration of devices in a dynamic network from the end-user – whether the environment be at home, in a car or e.g. in an automated factory. UPnP is based on a notion of a peer-to-peer network, where devices can locate each other and use a common mechanism to communicate their status and abilities to each other, and to let those abilities be utilized by other devices.

The universality in the name of the protocol can be thought of as referencing several issues. For instance, the protocol is device-agnostic, and is designed to connect any devices – e.g. PCs, mobile devices and CE devices - independent of their architecture, software platform or supported programming languages. The underlying communication mechanism can be of any kind that allows the devices to transfer data in an IP-compatible way (Internet Protocol, Postel 1981), and any number of different network technologies can exist in the same dynamic network. UPnP utilizes existing, open network standards that are in wide use and well supported. The defined interfaces can be extended by device vendors to support further services, in a backward-compatible way. Finally, UPnP supports device control over application programming interfaces (API), regular web browsers, and device-to-device interfaces specific to device classes.
Device Control Protocols (DCP) are used to specify groups of devices that share a common set of services. An interface is designed for that set of services that can be used over common protocols by any device requiring those services. Currently existing device categories and the DCPs belonging to each category are listed in table 1. Each DCP usually contains several device and service specifications, potentially one for each device role and service available in that category.

Table 1: UPnP Device Categories and DCPs (UPnP Standards 2007)

Device Category	Device Control Protocols
Audio/Video	MediaServer V2.0 and MediaRenderer V2.0 MediaServer V2.0 and MediaRenderer V2.0
Home Automation	Digital Security Camera V1.0 HVAC V1.0 Lighting Controls V1.0
Networking	Internet Gateway V1.0 WLAN Access Point V1.0
Printer	Printer Enhanced V1.0 Printer Basic V1.0
Remoting	Remote UI Client V1.0 and Remote UI Server V1.0
Scanner	Scanner V1.0

Conceptually UPnP divides the roles of network elements into control points and devices. A control point is an element originating an action, for instance a media server connecting to a WLAN access point for internet access. Devices are elements that offer services to control points. A device can naturally assume both roles for several services.

Functionally UPnP is divided into six parts - addressing, discovery, description, control, eventing and presentation. *Addressing* is based on the Internet Protocol and enables targeting communication to the desired device. An existing Dynamic Host Configuration Protocol (DHCP, Droms 1997) server can optionally be utilized; otherwise the protocol falls back to random address selection and Address Resolution Protocol (Plummer 1982) to resolve address collisions. *Discovery* allows devices to advertise their services to the network, as well as control points to search desired services. Both of these functions are handled using the Simple Service Discovery Protocol (Goland et al. 1999). *Descriptions* are used to inform other devices of the type of a device and the services it provides. A device description contains vendor- and device-specific information and the service description lists the actions that can be invoked on the device. Descriptions are accessed with simple HTTP GET requests (Hypertext Transfer Protocol, Fielding et al. 1999) to the device of interest. Descriptions are represented using an XML-based format template. *Control* refers to the invocations from the control point to the services of a device, knowledge of which has been gained from descriptions. The invocations are made over HTTP as remote procedure calls that possibly modify the state of the device or service, and then return a result or an error. *Eventing* refers to an event mechanism that allows services to notify control points of changes in their state. A control point can subscribe to listen to changes in the variables listed in a service's description, and when changes in the state occur, the device notifies the control point of the new state with an event. *Presentation* is a slight misnomer, and refers to the possibility of controlling the device with a web browser. If such a possibility exists, the URL is included in the device description. The contents and the level of control are wholly defined by the device vendor.

At the heart of the UPnP is the idea to move only data, not executable code or platform-specific formats. This way each vendor can choose how to handle the data, and is not tied beforehand to a specific solution. Some services do require agreeing on a media format, but the protocol strives to provide flexible default values, which can be renegotiated between devices.

3.3 DLNA Guidelines

This chapter introduces the philosophy behind the DLNA guidelines and presents a technical perspective to the outputs of the organization. This chapter draws mostly on DLNA's white papers on the organization's targets (DLNA Overview and Vision White Paper 2007) and on home connectivity Use Case Scenarios (DLNA Use Case Scenarios 2007).

DLNA is an industry consortium that was established in 2003, and has in April 2007 more than 220 member companies (DLNA Member Companies 2007). Member companies mostly work in the areas of CE, computer devices and peripherals, and mobile devices. These areas also define the three islands into which the DLNA vision separates the digital home environment in its current state. The goal of the organization is to provide guidelines for implementing communication between the devices, both within and across these islands, in a way that is both interoperable and transparent to the user. The first version of these guidelines was published in 2004, and the second version with a significantly expanded scope was published in 2006 in the DLNA Networked Device Interoperability Guidelines Expanded.

DLNA guidelines are based on a set of usage scenarios that the organization sees as typical and valuable to a consumer at the moment and in the near future. Usage scenarios are sought to be built on consumers' technology-independent needs, so that they are unlikely to easily change in the future. Widely used standards or practices are included in the guidelines to fulfill the requirements of each scenario, and strict guidelines are designed to remove any ambiguities from the selected specifications. DLNA does not insist on the total openness of the chosen standards and practices, but claims to seek reasonable accessibility of included technologies.

A set of building blocks are defined in the guidelines for use in implementations. These building blocks are sets of technologies chosen as possibilities for solving a specific need of a usage scenario. The building blocks and their related technologies are listed in table 2. As can be seen from the list, the guidelines are not limited to specifying communication mechanisms, but also define content formats in one end, and specific network technologies in the other.

Table 2: DLNA Guideline Building Blocks (DLNA Overview and Vision White Paper 2007)

Requirement Area	Chosen Technologies
Media Formats	MP3, JPEG, LPCM, MPEG2, MPEG4 AAC LC, AVC/H.264
Device Discovery, Control and Media Management	UPnP AV 1.0, UPnP Device Architecture 1.0
Media Transport	HTTP, RTP
Network Stack	IPv4 Protocol Suite
Network Connectivity	802.3i, 802.3u, 802.11a/b/g, Bluetooth

The guidelines specify three device categories, each of which contains several device classes that represent a certain role of a device in that category. These classes are listed in table 3, under their related categories.

Table 3: DLNA Device Classes and Categories (DLNA Overview and Vision White Paper 2007)

Home Network Devices Category	Mobile Handheld Devices Category	Home Interoperability Devices Category
Digital Media Server (DMS)	Mobile Digital Media Server (M-DMS)	Mobile Interoperability Unit (MIU)
Digital Media Player (DMP)	Mobile Digital Media Player (M-DMP)	Mobile Network Connectivity Function (M-NCF)
Digital Media Renderer (DMR)	Mobile Digital Media Uploader (M-DMU)	
Digital Media Controller (DMC)	Mobile Digital Media Downloader (M-DMD)	
Digital Media Printer (DMPr)	Mobile Digital Media Controller (M-DMC)	

A *Digital Media Server* (DMS) is a component capable of storing and sourcing media. A DMS can be implemented e.g. in a set-top-box, a digital video recorder, or a PC. A *Digital Media Player* (DMP) can acquire media from a DMS and play it to the user. A DMP could be for instance a television or a home theater system. A *Digital Media Renderer* (DMR) has the ability to show to the user the content provided to it by other devices - in a sense it is a “passive DMP”. Such a device could be for example a display with capabilities limited compared to a DMP. *Digital Media Controllers* (DMC) can initiate activities as a third-party controller, for example to start the display of a media from a DMS on a DMR. Finally, a *Digital Media Printer* (DMPr) is able to print the media sent to it.

The Mobile Handheld Devices (MHD) category also contains device classes for server, player and controller functionality – M-DMS, M-DMP and M-DMC, respectively – corresponding to those in the Home Network Devices (HND) category, with the requirements adapted for a mobile device. Additionally, the class contains a *Mobile Digital Media Uploader* (M-DMU), which can send media to a server, and a *Mobile Digital Media Downloader* (M-DMD), capable of finding and downloading content from a server to the mobile device.

Finally, the Home Infrastructure Devices (HID) category contains two device classes: *Mobile Network Connectivity Function* (M-NCF) for bridging between HND and MHD networks, and *Media Interoperability Unit* (MUI) to provide media conversions required between HND and MHD device classes. In other words, these classes provide facilities to an environment where devices from the first two categories are expected to interact.

As can be seen from the device class names, DLNA guidelines a targeted specifically to provide interconnectivity in the home network, and no other application areas are considered. The organization does, however, envision expanding the guidelines to other areas, such as home control and communication, as the need arises.

4. Roles of UPnP and DLNA in the Market

UPnP was designed as a multi-purpose protocol to match versatile application areas, even though it has been most visible in the home connectivity environment. Market dominance can hardly be boasted, but a fair base of implementations does show that the UPnP specifications are taken seriously. At the moment there are devices in the market at least in the categories of media servers, network routers and modems, home automation systems, storage systems, game consoles, mobile phones and remote controllers. In addition there are quite a few software implementations for different operating systems, aimed for instance at providing media server functionality with the PC. Although some devices with UPnP support have gained a lot of publicity, UPnP itself has remained largely a footnote.
DLNA has taken a great deal more focused approach to home connectivity than UPnP. The target area has so far been clearly in the connectivity of home devices, and even more particularly, home devices in the work, entertainment and communication fields. In these chosen areas the DLNA guidelines go into significantly more detail than the UPnP standards, and leave little up to the implementations to decide – apart from the selection among an allowed set of technologies for a particular purpose. DLNA support seems to be scarcer than UPnP support in devices currently available, but devices in all targeted application areas exist already.

5. Conclusion

Both UPnP and DLNA have been implemented in several interesting devices, but neither has acquired the critical mass that would be required for wide-spread adoption. That is, so that a consumer could expect a device purchased for a specific purpose to cooperate with the existing devices at home. At the moment, the connectivity support remains just as an interesting option that informed users can enable at will.

Even though the market situation for UPnP and DLNA is rather similar, the conditions for each are somewhat different. The slightly wider spread of UPnP may be in part due to its longer period of availability, but another consideration may be that UPnP is a more loose specification that can be applied to a specific situation – for instance, to open the route to the Internet for a media player through a firewall. In such a situation the high vertical stack of DLNA requirements would be an overkill, not to mention a significant cost.

The other side of the issue of simplicity versus complexity is the compatibility of the solutions. This could be seen as the reason for establishing DLNA in the first place – there is significant overlap in the member lists of DLNA and UPnP, so it is possible that many of the members of the UPnP Forum saw a need for more comprehensive specifications. Parts of UPnP standards are utilized in DLNA guidelines, so the problem does not seem to lie within the UPnP standards as such. However, the narrow targets of specific UPnP implementations are unlikely to result in a UPnP "universe" in which two arbitrary devices could be expected to cooperate using UPnP, even though the protocol might ease configuration in selected cases. DLNA, on the other hand, with its perceived complexity due to strict specifications, aims to solve this particular problem. DLNA-compatible devices are in all cases fully compliant members of the home connectivity environment, and can reasonably be expected to work together.

UPnP is a sufficient tool for the purpose it was designed for, but the design view seems to be too wide for a comprehensive home connectivity standard. DLNA provides strict guidelines for carefully filtered use cases, and has the support of major players in the home device market. Thus it seems likely that if the implementations continue to emerge, DLNA has the potential to become the connecting tissue of the home devices.

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MOBILE AS A CHANNEL

Pär Österlund
Helsinki University of Technology
par.osterlund@tkk.fi

Abstract

This paper presents the mobile internet as a channel and analyzes the user- and business consequences of integrating the mobile channel with other channels and allowing integration into the mobile channel. The main focus is on the mobile operator business with Japan and Finland as case examples.

Key Words
mobile channel, channel integration, operator business

1. Introduction

The successful and unsuccessful launches of the mobile internet in different countries have been analyzed from many perspectives like consumer behavior, service concepts and product strategies (Macdonald 2003, Barnes&Huff 2003), but the channel view and the issues on channel integration have not been widely analyzed.

This paper tries to provide an introduction into viewing the mobile internet as a channel. The channel view is used to find success factors for the mobile internet in channel integration as viewed from the possibilities for 3rd parties to integrate into the channel and for end users to use the mobile channel integrated with other channels, mainly the Internet and its services.

The focus is on the mobile operator and its business. Content and service providers and the end user are discussed from the viewpoint of the operator. The role of the handset manufacturers is not discussed in detail. It is assumed that users are critical for the mobile operator and thus increasing usage is the goal in this paper and the on laying business models are not discussed in detail.

The main point is to argue why it is beneficial for mobile operators to view the mobile internet as a channel and to assess the integration issues and provide a checklist of issues to keep in mind when launching a new concept of the mobile internet.

This paper follows the terminology used by Saarikoski (2006), referring to the mobile internet as such and separating it from the concept of the Internet. For clarification internet is the common noun and Internet the proper noun.

For structure the channel concept is first motivated in Chapter 2, then in Chapter 3 channel integration is discussed. Chapter 4 provides practical examples from Japan and Finland and Chapter 5 concludes the topic and provides a checklist for mobile operators launching concepts of mobile internet.

2. Mobile Internet as a Channel

The Merriam-Webster dictionary defines a channel as “a means of communication or expression” and more exactly as “a path along which information (as data or music) in the form of an electrical signal passes”. In the light of this definition the mobile internet is convenient to view as a channel in the same way as the Internet, a telephone service or an information desk.

In this paper the channel is more conceptual than technical. Viewing the mobile as a channel is meant in the same way that a web site can be a channel for a customer to receive information from or a plane is a channel to deliver goods through instead of viewing the mobile as a channel to merely transport bits through. In other words the channel transports some kind of added value to the end user.

In the field of marketing the mobile has been seen as a channel for a long time already (Müller-Lankenau et al 2004, Kotler & Keller 2006) and more recently the channel viewpoint has been identified by more technology focused writes too (Barnes & Huff 2003, Soininen 2005). Soininen (2005) identifies that from the media industry perspective the providers of information technologies and communication infrastructure are providers of channels and appliances for communication. Based on this one could say that the mobile is essentially a channel from the business perspective of 3rd parties. It should be analyzed as such by the mobile operators providing it. By doing this the operators can relate more to those customers and partners that are not the end users.

As a part of the media mix or the channel mix the mobile is subject to the same demands of channel management and integration in a multichannel environment as all the more traditional channels. Channel strategies have been researched extensively and most agree that the strategies vary from single channel to integrated multichannel with different hybrids in between (Müller-Lankenau et al 2004, Payne & Frow 2004). It is noted in marketing literature (Kotler & Keller 2006) and papers (eg Müller-Lankenau et al 2004) that more and more companies are using a multichannel approach to reach their customers. This implies a trend of at least non-pure-click companies moving towards the more integrated approach. According to this trend the channel also needs to be able to integrate more and more into other channels in order to bring business benefits for the parties using the channel.

The common reasons for having a multichannel approach include customer demand, customer profitability, costs, competitive advantage, customer relations management, convergence of channel roles, variety in channel usage and regulatory pressure (Stone, Hobbes and Khaleeli 2002). From these reasons we see that companies outside the mobile business have potential to expand their multichannel approach to include the mobile channel as well, and these companies should not be ignored when assessing the mobile channel.

Saarikoski (2006) also identifies the importance of having a multichannel approach towards the mobile channel, but discuses more the principles of having the same content and services available with the same rules, than channel integration related issues.

3. Channel Integration

There are essentially two types of channel integration.

1. Integrating into the channel (vertical)
2. Cross-channel integration (horizontal)

For terminology Macdonald (2003) refers to integrating into the channel as vertical integration and cross-channel integration as horizontal integration. The same terms will be used hereafter.

3.1 Vertical Integration

Definition: Vertical integration is integration of the different actors of the mobile value chain into the channel. The different actors in vertical integration are presented below in Figure 1.

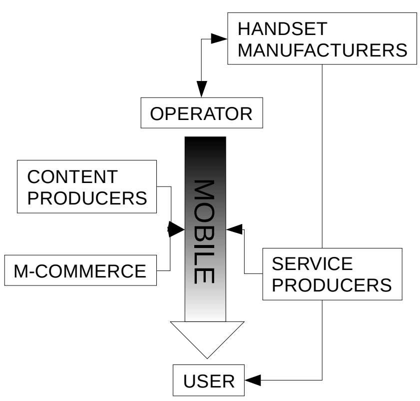

Figure 1: The actors in vertical channel integration connected to the channel

The most important point in vertical integration is to make it as easy as possible to provide content and services to the channel and get it published through there. The reason for the operators to do this is simple. If there is no content and no services there are no users. If content and service production and publication is difficult, there is no, or little, content and services. So in order to get a strong user base, content and service creation needs to be as easy as possible.

Easy production and publication into the mobile channel lowers costs for the providers and thus makes it easier to achieve a win-win model as is presented later as one of the reasons that made Japanese i-mode a success.

A reason for operators not to make integration easy is control. If you allow virtually anyone to create anything to be used through your channel you lose control over it. From the operator point of view this would lead to a similar setup as for fixed line Internet operators, who provide the channel and have to work hard to get users to use their content and services that are available. Keeping a higher threshold keeps entry barriers high and thus limits the pace of change.

As noted earlier multi-channel strategies are becoming more and more common, making it important to be able integrate into the mobile channel in the most feasible way. This way multi-channel integration can be done on terms of the business and its processes.

In a business of low entry barriers it is inevitable that channel structure is going to change over time (Kotler&Keller, 2006), which makes it even more important to assess the possibilities of using the channel in a different way in the future. If integration into the channel is made difficult, changing as the market changes will be difficult.

The role of the handset manufacturers in the channel is an interesting question. Barnes&Huff (2003) write about the vertical integration with hardware manufacturers as one key to i-mode success, but they discuss the possibilities of the operator influencing the features of the handsets and lowering the costs to the end users through economies of scale. The features of a handset are enabling factors in the different services provided in the mobile channel and since related, but the manufacturers do not actually integrate into the channel. The handset manufacturers have contact with both the operators through providing handsets to them and their users, and to the end users, as they actually use the handsets manufactured. The manufacturers are thus placed outside the channel in Figure 1, and treated as a technical enabler of the channel or as Soininen (2005) described it, a provider of appliances for communication.

3.2 Horizontal Integration

Definition: Horizontal integration consists of integrating the channel with other platforms and services working in other channels. Examples of different kinds of horizontal integration are presented in Figure 2 below.

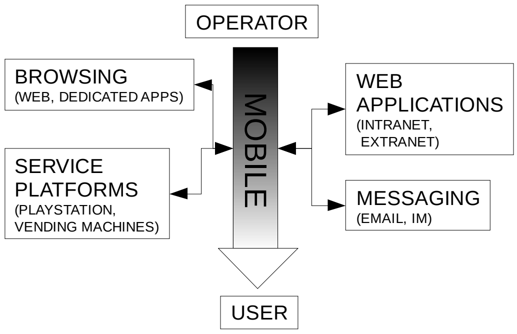

Figure 2: Different channels connected to the mobile channel

Integration with other services and channels is vital. Cross-channel integration can make content from normal web pages and regular email systems accessible through the mobile. This way the user can use the same services he/she is used to in the fixed line Internet world and thus content existence is not a problem. Nor is there a question whether content should be created before users start to use a system or not, because content already exists. Depending on the service content might still be an issue from the usability perspective. Normal web sites are still not as usable on mobile handsets as on desktop computers, but for instance email and instant messaging work in a very similar manner not depending on the client used.

Saarikoski (2006) notes in his recipe for a successful mobile internet in Europe, that the mobile internet should converge with the Internet and that a “mobile internet island – a walled garden” should not be built. This means extensive horizontal integration between the mobile and the fixed line internet, i.e. the Internet.

Cross-channel integration through using the same technologies let the developers use the same tools for content and service production as for other channels. Instead of a learning curve the content and service production can start instantly, hopefully resulting in cheaper development costs and shorter time-to-market.

Horizontal integration can also integrate into new types of channels or services. An example of this kind of integration is vending machines using mobile payments or linking the mobile with Playstation (Macdonald 2003). This kind of integration can be done reactively or proactively by the mobile operators. Reactive allows for the integration to happen and proactive pursues the new integration opportunities and partners with other players in the field to make it happen. The proactive way gives the operators more control, since they are involved themselves and thus lowers the risk of becoming a less significant actor in the field.

4. Examples of mobile channel integration: comparing NTT DoCoMo's i-mode in Japan to operator solutions in Finland

As i-mode, launched by Japanese operator NTT DoCoMo, is often portrayed as a successful concept of mobile internet (Macdonald 2003, Barnes&Huff 2003) it is analyzed as a case example of successful integration strategies. Summarized i-mode is a concept for mobile internet usage allowing the users to browse i-mode sites, use email and more. For a more detailed description of i-mode, refer to Macdonald (2003) or Barnes and Huff (2003).

As of February 28th NTT DoCoMo had 52.3 million subscribers of which 47.3 million were i-mode subscribers (NTT DoCoMo 2007). With almost 90% of the subscribers using i-mode, it is motivated to call it successful.

Generally the Finnish model is seen as less successful, specially compared to i-mode. Opposed to i-mode in Japan the Finnish mobile users used their phones for browsing in 13% of the cases and for using email in 13% of the cases (Ficora 2006). Comparing the usage percentages of 13 and 13 to almost 90 leaves us to conclude that i-mode has been far more successful.

4.1 Vertical Integration

Apart from the Finnish WAP/WML model i-mode was based on HTTP/HTML providing an easy way for content providers to use their content in i-mode with minimal conversion and learning efforts. iHTML used is a subset of standard HTML versions 4, 3.2 and 2 and additional special tags, such as links to call a number: “tel:” (NTT DoCoMo 2002).

Finland has heavily promoted WAP and still is, as an example the operator Elisa launched an advertising campaign in the spring of 2007 promoting their wap.elisa.net WAP portal.

To make integration into i-mode as easy as possible NTT DoCoMo provides a “Let’s make i-mode contents”-initiative with instructions how to technically create content and how to submit content into the i-mode Menu. The i-mode Menu is the default menu for i-mode browsing acting as a portal for i-mode users to browse to the content they wish (Macdonald 2003). Content can be submitted by anyone fulfilling the service criteria without charges. Criteria include general criteria for quality content, such as “Official i-mode contents shall conform to good common sense and shall not damage the trust of i-mode users”. (NTT DoCoMo, 2007b)

In Finland the default service is often the operator WAP portal, e.g. for Elisa and Saunalahti. An extensive search targeting the operator web pages and content portals does not reveal any information about the possibilities on getting content or services listed in their portals (as of April 2007). Nevertheless it might be possible and it might even be free, but far from as easy as with the NTT DoCoMo initiative.

Macdonald (2003) additionally notes that NTT DoCoMo provided a win-win business model transferring the generated revenue minus 9% to the original producer. i-mode thus makes it easy to generate revenue through the channel. As a comparison the Finnish operators started with a commission of about 60%, lowering it down to 20-30% in 2004 (Saarikoski 2006).

4.2 Horizontal Integration

Using the standards HTTP and HTML as a base allowed i-mode to integrate into existing services more smoothly. Since the technical differences are minor existing HTML content could be used with minimal effort compared to WML pages and WAP, which need total conversion.

Beyond browsing the communications standard of i-mode is email, which already has a strong user base in desktop computing, allowing desktop and mobile users to exchange messages seamlessly. This choice integrates the mobile messaging to almost every other Internet enabled platform including not only desktops but also mobile devices outside of i-mode.

In Finland MMS messages have been promoted, but they have not become a success like SMS messages. From the channel integration point of view the MMS messages integrate poorly into other channels. Only users with MMS enabled phones can receive the messages and otherwise the message has to be viewed from a normal web browser from the operator home page. Also MMS messages can only be sent from mobile phones, not through an open protocol over the Internet for example.

Saarikoski (2006) suggests the move from SMS to WAP for operators and content providers. I strongly agree that moving away from the SMS platform is worth encouraging, but I would like to suggest moving to standard HTTP/HTML platform instead because of its superior integration abilities.

4.3 Other viewpoints connecting to channel integration

Other viewpoints on the success factors of i-mode have been presented. Barnes and Huff (2003) look at the success mainly using technology acceptance theory through Rogers five key characteristics, namely Relative Advantage, Compatibility, Complexity, Trialability and Observability extended with Image and Trust factors.

Even though not noted by the authors many of these characteristics can be connected to channel integration. Compatibility with what people do is achieved through letting them use the channel as is appropriate for them and thus letting them use it in interconnection with whatever other channels they want to use.

Many characteristics connect back to using a familiar service through a new channel. Through familiarity the perceived complexity of the service is lower, it is easier to try out and easier to trust. The results of using the service can often be verified using another channel, for example email sent from the mobile can be read on the desktop computer and as such the familiar service can reinforce observability.

Most characteristics of technology acceptance theory can be linked back to channel integration, but it is technology acceptance theory that explains the channel integration issues and not the other way around. Nevertheless this connection reinforces the use of channel integration as one tool of assessing the potential success of the business model used by mobile operators.

5. Conclusion

It is shown in this paper that it is motivated to view the mobile as a channel from a business perspective. It is further shown that channel integration issues explain several factors of failure or success for mobile internet. Nevertheless channel integration only explains success and failure from one perspective and it is not a sufficient tool alone to assess the mobile internet, but it complements other frameworks and viewpoints, such as consumer behavior, service concepts and product strategies. For the mobile operator several key issues were raised. The operators should ask themselves the following questions when launching a concept of mobile internet.

Vertical integration

- Is it easy enough to create content to be used in the mobile channel?
- Is it easy enough to publish content through the mobile channel?
- Is it easy enough to generate revenue through the mobile channel?
- Is it easy and flexible enough to integrate services into the mobile channel?

Horizontal integration

- Are services and content from other channels easily accessible for the end user?
- Are you actively pursuing opportunities to integrate the mobile channel with new platforms and channels?

Asking themselves these questions should help the mobile operators to form a general view over the integration issues concerning the service and help assess its possibilities for success.

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MOBILE GAMES BUSINESS

Anssi Vanhanen
Helsinki University of Technology
Telecom and Multimedia Laboratory
HUT, Espoo, Finland
anssi.vanhanen@tkk.fi

Abstract

The paper discusses mobile gaming business mainly from the 3rd party game developers' point of view. Research methodology used is literature study. The subjects discussed in the paper include: past expectations on business potential, actual financial results, forecasts, mobile gaming market, marketing methods, software platforms, end terminals, business models for mobile game developers and related value chains. In the process of gathering information on such a wide-ranging subject, the contributions of this paper have shifted from presenting explicit answers closer to facilitating discussion and providing more questions. The contributions of this paper in the form of statements and suggestions, some of which are in need of backup from further research are: 1) although the number of companies and handsets may be an indicator of the potential of mobile gaming, they are not a credible indicator of game buying, 2) context-based advertising and serving selected niches in context of use could be a more effective and efficient way to gain customer mass than mass-media advertising, 3) developers of J2ME had to make a lot of compromises in its standardization and left too much freedom in terms of implementation to the end-terminal manufacturers, 4) if Moore's law holds in hand-held devices, the strategy of writing software to address the needs of future instead of current devices may work in the hand-held market, 5) OTA business model enables larger circulation, but on the other hand, the protracted value chain with the significant power of carriers and game publishers leads to limited margins to game developers, 6) gambling on mobile phones seems like a sustaining innovation to online gambling companies, but can be a significant extension to their business models, and 7) past financial forecasts of mobile gaming may not be reached, partly due to recent legislation changes in the US since many of the forecasts have counted in the potential revenue from mobile gambling. The author also suggests a certain categorization of mobile gaming business models which has evolved in the process of this literature study. However, there are three significant constraints in this research: availability of relevant research, lack of reliable industry data and time constraints due to limited scope of the work.

Key Words
Mobile Games, Business, Business Models

1. Introduction and Structure of this Paper

The paper discusses mobile gaming business from the game developers' point of view and strives to cover most relevant aspects of the business. In the process, several separate areas are touched to get a holistic view on mobile gaming business. The second part presents past expectations on mobile gaming. The third part shows some indicators of actual financial results. The fourth part discusses the mobile gaming market and presents a fictituous example of how context-based advertising could be utilized in marketing mobile games. The fifth part discusses technology in relevant extent from game developer's point of view: software platforms, end-terminals and challenges in them. The sixth part presents a categorization of relevant business models to game developers, though leaving some to lesser attention. The sixth part also discusses value chains in mobile gaming business and the players, their roles and relevance in the chains. And last, the seventh part presents some forecasts of the business. The paper contains some material from IGDA (International Game Developers Association) and excerpts from interviews available at Sun Developer Network. Conclusions, suggestions and speculation made by the author are presented separately at the end of each part due to the vast range of subjects that are touched in the paper.

2. Expectations on Business Potential of Mobile Gaming

Gambling could be the killer application that will help make third-generation cell phone licenses pay off. Promoters of mobile gaming think it will attract a new breed of gambler, including a younger, more upwardly mobile crowd. (Schenker 2001) The global mobile games market in 2001 was suggested to be around $400 million (Nokia 2003). The estimates for the future sales went to around $7 billion in 2006 for Europe alone (Gamespot 2003).

"The serious gamers, single males between 15 and 27, will generate the greatest percentage of revenue for the mobile gaming industry over the next few years", stated Giga's Smiley in 2003. Kathleen Maher, vice president of Jon Peddie Research, disagreed. "I don't see serious gamers going for handhelds as their platform of choice anytime soon because the platform simply doesn't allow for engaging game play in the way that consoles and

PCs do". "They will play [wireless] games only when they are mobile and can't do anything else". (Neal Leavitt 2003)

According to ITU, by mid-year 2005, total worldwide subscribers totaled 1.5 billion, double the size it was in 2000 and up from 1.3 billion by the end of 2003. Nokia believed that the worldwide subscriber base would grow to 2.0 billion by 2007. In comparison, the number of personal computers in use worldwide in 2004 was 575 million. The growing number of end-terminals is one of the reasons why the mobile games market has seemed so lucrative (Engelsma, Ferrans, Hans, Shi, Vasudevan 2006). However, for mobile gaming, the total subscriber base is not as relevant as the installed subscriber base with data enabled handsets. IDC estimated that in 2004 there were 692 million 2.5G mobile devices shipped capable of data transmission (3G devices not included). (IGDA 2005)
Screen Digest forecasts suggest that worldwide mobile game revenue would grow 56 percent to $3.2 billion in 2006, with more than two-thirds of sales coming from vibrant overseas markets like Asia and Europe. Even so, such forecasts pale in comparison to estimates issued earlier this decade, when analysts suggested the global market could hit $10 billion in 2005 (Spill group 2005). The tables below highlight the some of various projections for the market size and the growth opportunity. (IGDA 2005)

Global Gaming Revenue:

Source/Year	2003	2008	CAGR %
ARC ($MM)	$1,100	$8,400	50%
Screen Digest ($MM)	$1,100	$4,200	31%

According to IGDA, another indication of the expected continued growth of mobile games was the venture capital funding being received by proven players as well as new start-ups. Also, acquisitions were an indicator of business potential. Funding and acquisitions made in 2004 can be found in appendix A.

3. The Outcome

However, despite the excitement about financial prospects of OTA (Over The Air) gaming, the results so far have been uninspiring. It was estimated, for instance, that in 2006 the mobile gaming market would have languished at around 800 million Euros. With 60% - plus growth rates predicted in the mobile games market in the coming years, the problem is perhaps that analysts have been counting the wrong thing. The fact is that game playing does not equal game buying. And although the number of mobile game users in Europe might well be significant, the number of people who actually buy games OTA remains miniscule. Studies show, for instance, that in the UK only about 3.8% of mobile users who play games on their handsets have actually downloaded one. In Germany, the figure is 2.1% and in the US 2.5%. That means that more screensavers and wallpapers are purchased in those countries than mobile games. It also suggests that forecasts of 60% or more growth each year in this market are probably way off the mark. (Frost & Sullivan 2006)

A mobile gaming brief from eMarketer found that mobile gaming is growing in the US and globally, with $2.5 billion in worldwide mobile gaming revenue for 2005. (eMarketer 2006).

Contrary to the optimism expressed in most industry forecasts, mobile gaming markets are growing extremely slowly in revenue terms – unlike, say, in the mobile music sector where growth rates are skyrocketing. The problem is that although consumers are increasingly playing mobile games, they are not at all keen on buying them. Indeed, even though mobile games have been around for more than a decade, they have yet to succeed in generating significant profits for the region's mobile operators.

The problem is partly historical. Games started out being embedded into mobile handsets, which helped drive sales of new devices but also got consumers used to not having to pay for them. Maybe operators and publishers need to accept the likelihood that mobile gaming is destined to remain a niche activity. And perhaps their best bet in order to make it more mainstream might actually be to bundle games offerings with other applications, such as music, or else with various types of merchandise, where the consumer is likely to see a more tangible benefit.
(Frost & Sullivan 2006)

Women and puzzle games steered the mobile game market to strong results in the first quarter of 2006. Puzzle and strategy games generated one-third of the total revenue in Q1 for the U.S. mobile game market, with a full 65 percent of all mobile game revenue generated by female wireless subscribers, according to research from Telephia's Mobile Game Report. According to the report, female wireless gamers contributed 72 percent of the revenue generated by puzzle and strategy games. The most popular games among females were mobile titles categorized as trivia and word games, such as Cosmic Infinity's "Who wants to be a millionaire" 2005. While this category represented only 11.4 percent of overall mobile revenue for the quarter, 74 percent was attributed to the female audience. "The casual nature of mobile games provides tremendous appeal to women who are not traditionally hardcore gamers by console or online gaming standards," says Kanishka Agarwal, vice president of new products at Telephia. The report also found that four of the top five revenue-generating titles were puzzle or strategy-based games, with Tetris, Tetris Deluxe, Bejeweled and Mahjong securing the top spots. Four of the top titles were published by EA Mobile.

It remains very early days for mobile games, video and music, however. Game revenues continue to increase, but many believe the market has stalled following quick uptake by early adopters. (Gibbs, RCR Wireless News 2006).

4. Mobile Gaming Market

Generally speaking, carriers are reluctant to share research, gaming habits and sales and thus mobile analysts focus on industry numbers: companies, revenue, handsets and technologies than on consumers. MMetrics, a mobile data company, stated that in November 2004 over 10 million mobile subscribers downloaded and paid for games on their phones. In contrast, 47.1 million played games that were already embedded into the handset.
The author speculates that the logic behind some of the boldest forecasts may have been largely based on the number of handsets. Although the number of companies, technologies and handsets may be an indicator of the potential of mobile game playing, it does not equal game buying. Comparing the number of mobile phones to the number of consoles is not a valid base to draw conculsions: mobile phones and game consoles are bought for different purposes.

The mobile industry is beginning to challenge some of our fundamental assumptions about gaming. Recent research revealed, for example, that while gaming is often perceived as one of the last surviving bastions of male dominance, women are in fact playing mobile games longer and harder than men. That's just one of a number of dramatic trend-shifts taking place as games continue their migration onto mobile devices. But worryingly, such changes have yet to translate into actual revenue for the industry. While the revelation about women playing mobile games more often and longer than men might help operators target their game offerings better, it remains unclear how they can translate such insights into commercial success. (Frost & Sullivan 2006)

The recent market trends in the mobile games business are that traditional video game publishers are jumping in, there is an increased availability of games, quality of games is enhancing, network capability is improving and there is a solid growth projection. (IGDA 2005)

A research conducted by Sorrent in February 2004 indicated that 60% play games once a day or more, 30% play games more than 3 times per day, more than 60% typically play games at home, more than 70% play for longer than ten minutes at a time, more than 60% are between ages 18-26 and single, more than 70% are sharing mobile gameplay on their phones with friends or family members and most people who download games learn about them through "word-of-mouth". Thus, the common assumption that mobile gamers are either core gamers playing console-like ports or a mass market consumer bored in their "downtime", does not hold. The Sorrent study revealed that mobile gaming is more than killing "downtime": People are playing at home (more than 60%); playing for long periods of time (15-20) minutes and playing frequently (more than 65% play more than once a day).

According to the author's personal experience, in Finland mobile games are often advertised in TV during programs targeted at young adults (aged 18-26) which according to the research were the majority of mobile gamers. Mobile games are also advertised in TV during the night in mobile chats, some of which are related to online/mobile dating, and are likely targeted at singles or either inactive night-workers. However, finding data to support these arguments is difficult. Nevertheless, it seems that quite a lot of money is invested in mass advertising based on traditional market segmentation to target certain demographics.

The author speculates if context-based advertising could be both more effective and efficient. Strategic segmentation would view the marketing process as follows: 1. who to serve, 2. what to offer, 3. how to deliver (Mattsson 2006). The author illustrates this proposition by a fictitious example of a 20-year-old snowboarder.

4.1 Strategic Marketing: The Finnish Snowboarder

Strategic marketing could choose to target snowboarders and skiers. In Helsinki Metropolitan Area, there are only a few downhill skiing centers. They are quite small and do not fully address the needs of active snowboarders/skiers. Thus, active skiers living in Helsinki Metropolitan Area often tend to travel further, nearer central Finland to fulfill their needs if they have the time. A portion of these young adults are likely to use cars of their own or of their parents in ridesharing, but the many of them will favor public transportation. All the equipment and people crammed into the same car could make the longer journeys uncomfortable. In addition, the common time spent in the bus with friends may actually be a part of the experience.

The bus travel to decent downhill skiing centers will take at least a few hours. During the trip, the skiers are bored and inactive and may be seeking something to amuse them during the trip. In this context, they could be persuaded to try and invest into a mobile game that sounds interesting to them. Word-of-mouth from one of the travelers could convince some of the others to purchase a mobile game over the air. Especially multiplayer games could be of interest to them in that context so that they could play against each other. Research shows that social interaction is a strong motive to attend a multi-user service, and it is influenced by three factors – context, communication and identification – that have to be considered when developing applications for multi-user purposes (Leikas, Stromberg, Ikonen, Suomela, Heinila, 2006).
However, since purchasing mobile games is not yet that popular in Finland, the chances are that there is no one in the group that would persuade others to do so.

Ads of popular mobile games, for example ones downsized from PC or console versions that have a strong brand and a promising foothold in the demographic group of snowboarders, could attract the travelers' attention. Targeting and serving them in the context where they have the need to play games, the time to contribute to playing and the opportunity to purchase the game over the air could be very effective. The game could be, for example, a multiplayer version of Worms (downsized multiplayer version of a popular PC game) or a popular snowboarding game. The games should be selected carefully to attract the travelers' attention since mobile gaming in this context has indirect competition from substitutes such as playing cards.

4.2 Convincing the Market: Areas of Further Discussion

The author suggests that this, serving selected niches in the context of potential use and purchase, could be a lucrative method to get non-consumers purchase and thus gain customer mass. After eventually reaching critical customer mass, positive network externalities would have a beneficial impact upon demand. This could have two consequences:
First, in the case of multiplayer games the value of a subscription to the network (community of players) would be higher when the network has more subscribers (applied from Luukkainen 2005). Second, word-of-mouth in the case of single and also multiplayer games could create a noteworthy snowball-effect and eventually lessen the need for expensive mass-media advertising.

The author's personal opinion is that perhaps mobile games are not advertised as efficiently and effectively as possible. Huge sums of money are invested in mass-media advertising that does not customize the offering to meet the needs of specific customer groups (or smaller niches) *in the context of use*. The barrier for a consumer to make his first purchase over the air may be significantly higher than making later purchases. Thus, the author suggests that consumers must be reached in the context of use and the offering must be customized enough to make the non-consumer make a first purchase. Mass-media advertising has its part, but perhaps a larger portion of the efforts in that could be directed in a more effective and efficient manner. Backing up these suggestions with solid facts is difficult since the needed information is not publicly available.

5. Software Platforms and Their Challenges

According to wikipedia, the most common platforms and technologies for developing mobile games are Windows Mobile, Palm OS, Symbian OS, Macromedia's Flash Lite, DoCoMo's DoJa, Sun's J2ME (Java 2 Micro Edition, recently rebranded simply "Java ME"), Qualcomm's BREW (Binary Runtime for Wireless), WIPI or Infusio's ExEn (Execution Environment). Java [J2ME] was initially the most common platform for mobile games, but its performance limitations have led to the adoption of various native binary formats for more sophisticated games. (wikipedia: mobile game)

Mobile Java applications have a performance penalty and lack of some Java features. Native OS games do not have that performance limitation. For example, Symbian OS applications have an improved performance in contrast to Java, but one of their downsides is that they are complex (Mobile programming course slides 2007, Tampere University of Technology)

BREW is a proprietary wireless application development platform. Its main advantage is that the application developers can easily port their applications between all the Qualcomm ASICs, but the applications must be digitally signed. Because BREW gives complete control over the handset hardware, only content providers or authenticated BREW developers have the tools necessary to create a digital signature. As of March 2006, the least expensive digital signature for testing costs 400 USD and is limited to 100 application submissions. This steep cost of entry excludes hobbyists from developing for phones that use BREW. The time and cost to market favors Java ME over BREW, because of BREW's rigorous certification requirements. On the other hand, higher entry barriers in BREW may create an advantage for established software developers who have more resources and do not have to compete with self-published hobbyists. (wikipedia: BREW)

Managing the deployment of games on mobile phones can be really complex. Developers have to create multiple versions of the applications, even if they write it in Java. (Lefevre, Pierson 2006).

5.1.1 Java ME

Java ME has become a popular option for creating games for cell phones, as they can be emulated on a PC during the development stage and easily uploaded to the phone. This contrasts with the difficulty of developing, testing, and loading games for other special gaming platforms such as those made by Nintendo, Sony, and others, as expensive system-specific hardware and kits are required. (Wikipedia: Java ME)

All modern mobile phones integrate now a Java Virtual Machine. These JVM allow providers to propose applications working on heterogeneous mobile phones. Most of the core of the application remains the same while some small parts of the code have to be adapted to the specific features of mobile phones: for instance, the memory available, the exact version of the JVM, layout of the components and graphics. Developers still have to create multiple versions of the applications. There is thus a need for generic tools to help programmers in the task of building mobile games that means to optimize their packaging and deployment on the end-users phones. (Lefevre, Pierson 2006)

A challenge that is universal among mobile software developers is that to maximize return, an application must support many, many different models of handsets, yet the expense and effort to adapt and test hundreds of versions can be daunting (Movilenio, Mobile Java Case Study, 2006).

Developers can create the source code that provides the basic functionality for any new game and develop a component that handles phone-specific features such as screen size, sound format, and the keyboard. This component can be readily adapted to support a new phone, while the base gaming module remains the same. When a new handset comes out, the team reviews its specifications, and then modifies just one component to develop a compatible version of the game rapidly. (Movilenio, Mobile Java Case Study, 2006)
However, Java game developers still have to publish hundreds of versions to cover the great variety of mobile devices (Zyda, 2007).
To illustrate the reasons and background for this, the author has included excerpts of an interview of Antero Taivalsaari of Sun Microsystems, one of the fathers of J2ME.

5.1.2 Java ME: Excerpts of Creator's Interview

According to Antero Taivalsaari, the main reason for the architecture of J2ME platform was the fragmentation of the embedded-systems market. Sun and Motorola who played a key role in the creation of the initial J2ME standardization activities realized early on that to create successful standards and products in the mobile Java area, they needed to have all the key players involved in the work.
On the other hand, there were so many different kinds of consumer and embedded devices that it would have been impossible to address the needs of all those devices with just one standard. If you added all the necessary features into a single standard, you'd end up with a system that would be way too large for any particular device. That's why the notions of configuration and profile were invented.
All the devices supporting the same configuration are assumed to have roughly the same amount of processing power, memory, and so on, even though the target markets of those devices may be entirely different. Profiles represent vertical market segments or different device categories. They address the needs of a particular type of a device, such as a mobile phone. For instance, MIDP defines a bunch of APIs that are specific to mobile devices.
There had been a lot of politics and confusion especially between the cell phone and PDA people which could have been avoided if UI (User Interface) libraries had been designed before publishing VM (Virtual Machine) technology. In this case, the developers' hopes that the industry would reach a consensus on the libraries quickly did not come true.
(Mahmoud, interview of Antero Taivalsaari, 2004)

5.1.3 Conclusions

The author suggests that the developers of J2ME had to make a lot of compromises in its standardization and therefore left too much freedom in terms of implementation to the end-terminal manufacturers. Reaching consensus later may have been difficult with the conflicting interests of device manufacturers. Further research is needed on the motives of end-terminal manufacturers regarding to their software platform strategies. Since device manufacturers have developed, invested in and committed to (their) proprietary software platforms, perhaps their conflicting interests have created a barrier too high for software platform convergence and an open, truly portable platform. One may ask if it is even in all their best interests.

5.2 End-terminals and Their Challenges

End-terminals are constrained in terms of memory, battery and energy consumption, screen size and resolution. From the aspect of mobile game development, limited screen size and resolution leads to less robust graphics and fewer pixels.
In addition, as stated in part 5.1, developers must design games that will work on various handsets with different screen sizes, color depths and Application Programming Interfaces (APIs). Also phone buttons are often limited to single key presses so the user is not able to control content by pressing several keys simultaneously
Also data files must be small to allow for easy downloading, although solutions such as Swerve by Superscape have been offered that let small devices access high-quality games by downloading relatively small amounts of data and use the processor to build the rest of the information.

In"Technology@Intel Magazine" issue of April 2005, the researcher speculated that Moore's Law may also apply to mobile phones. Moore's Law is the empirical observation made in 1965 that the number of transistors on an integrated circuit for minimum component cost doubles every 24 months.
Drew Lanza, general partner with Morgenthaler Ventures, points out that while the PC itself might be disappearing, mobile devices such as the iPhone are the new beneficiaries of Moore's Law. Until very recently chipmakers have used Moore's Law to pack more processing power into the same chip. But now, at last, they're focusing on putting the same amount of processing power into an ever smaller and cheaper chip, and using those transistors to do more than just crunch numbers. (Malik, Business 2.0 Magazine 2007)

5.2.1 End-terminals and Their Challenges: Conclusions

The author suggests that if Moore's law holds in hand-held devices, the strategy of writing software to address the needs of future instead of current devices may work in the hand-held market. Antero Taivalsaari stated in his interview from 2004 that Microsoft was trying to attack the wireless device space from the high end and use the same strategy familiar from the PC market making software for PCs that would eventually be fast enough to run that software. The author, however, states that the implications of Moore's law to the development of mobile applications depends on whether the device manufacturers rely on Moore's law to cram even more functionality and chips into the devices, make the devices smaller or really further increase their processing power. While the development times are not that long that anticipation of the future would be necessary in the case of traditional mobile games, it may offer an opportunity, for example to more advanced multiplayer games familiar from the PC space.

6. Business Models and Value Chains

Mobile game industry is closely related to two existing business areas, mobile telecommunications content business and computer and video console publishing business. In both these areas as in any content business, there are four operational phases: content creation, content aggregation, content marketing and content distribution. (Pelkonen 2004)

Nokia used the following categorization of business models in 2003: SMS games, browser games, java games, native OS games and N-Gage games (Nokia Corporation, 2003), a categorization which may not necessarily be valid anymore. In this research paper, messaging-based, browser and downloadable games are roughly categorized under OTA business model.

The categorization of business models and value chains presented in this chapter is based on the author's view and is a result of this study.

6.1 OTA (Over The Air) Business model

Over the air business model includes downloadable games, browser-based games and messaging-based games. The OTA value chain is similar to the case of traditional console and PC game value network. In OTA mobile game business, the most important players in the value chain are game developers, porting services, game publishers, device manufacturers, carriers and online portals (IGDA 2005).

Some reasons why operators are the preferred direct channel for around 80 percent of mobile games is that they have trusted brands, subscriber information and control the 'handset window interface' and the delivery channel to end users. Moreover, they are able to offer complete packages at competitive rates by exploiting their broad retail chains. Operators stand to gain revenues when games are downloaded through a portal and also when games or any other content is ordered through other channels. (Frost & Sullivan, 2003)

The players described in the following OTA value chain are significant in also other mobile gaming business models. Porting service, for example is a necessity if the game developer can not do it in-house and the game is targeted at a large set of mobile phones, regardless of earnings logic and consecutive value-creation activities.

6.1.1 OTA Value Chain

The description of OTA value chain is almost solely based on IGDA's white paper except for a few implications.

Game Developers:
Game developers are the creators and producers of the initial game concept to the final playable game. It is not sufficient just to develop great games, but also make sure that the games can be run on a variety of mobile phones. Thus, the games must support whatever the native API, graphic format or audio format is available. In addition, screen sizes and processor power variances cause additional design challenges. This complexity is multiplied by the number of dominant software platforms (in 2005, BREW and J2ME) that the game developers want to support. (IGDA, 2005). The result is that the number of individual game builds may be large. In SMS games, the game developer can get about 20 to 50 percent of revenue. In browser games (XHTML or WAP based), revenue shared with the developer can vary greatly. In North America developers get about 10 percent, while in Japan they get up to 90 percent (Semenov 2005).

Porting Services:
Many developers are not prepared to create these individual builds for the hundreds of devices available. Merely acquiring all the handsets is a challenge, not to mention the large commitments to testing and Quality Assurance required. Depending on the complexity of the game, the porting process usually exceeds the initial development costs. However, there are a few companies with the technology to ease this process through automated tools such as Tira Wireless. This is likely to become a trend due to the high cost of porting without a process that addresses handset diversity.

Game Publishers/Aggregators:
The basic business model of the mobile game publisher is the same as in the PC and console video game industry. Publishers plan a slate of titles based on IP they either own, create or plan to acquire and then match that IP to in-house or 3rd party talent to create a game. Publishers want their games as on many devices as possible in order to realize the full sales potential of any given title. This is not only driven by the publisher desire to support many platforms – carriers will favor games that support the widest selection of handsets. The newer models with a low installed base might not otherwise be targeted by publishers.

Handset Manufacturer:
The handset manufacturers are the mobile industry equivalent of game console manufacturers. The handset manufacturers embed different run-time environments into their handsets such as virtual machine or byte code environment like Java and DoJa. BREW, Symbian and

PocketPC Oss, provide binary runtime environments similar to Windows where applications are usually in a binary form. Handset manufacturers or their operator customers may have proprietary APIs which further fragments the market and complicates the porting process. Handset manufacturers play an important part in setting market direction of the technology that enables games and may in some markets play the role of distribution partner to publishers and studios.

Carriers:
Carriers are the equivalent of retail outlets in the traditional video game space. However, carriers wield significantly more power in the mobile gaming space than retailers do in the traditional game business because they have a monopoly over their very large customer base. Game selection is simply not a criterion for most people in choosing their carrier. Carriers provide the storefront and drive pricing, technology specifications, determine/enable various business models (e.g. subscription, one-time download, micro-payments), and provide the network that connects it all together. Carriers have the widest influence over the user experience in the value chain and they are currently well-served by existing publishers. The reason the carriers wield so much power is that today there is no meaningful alternative method of distribution. For game developers seeking to bring their art to mobile phones, it is important to realize that carrier are the gate-keepers to customers, and the established publishers are gate-keepers to the carriers.

Independent Channels:
This category contains all web, WAP and SMS sales channels not owned by the carriers. This also includes online portals run by device manufacturers and publishers and mobile content offerings on major fixed line portals. Device manufacturers have to make sure that content is available for all their handset models to make them attractive to end-users, and ensure content is available even when a model has just a small market, or limited penetration such as at launch. Devices sold through non-operator channels are often set-up to drive users to the device maker’s portals (eg. Club Nokia) for content. However, their traffic is very limited in comparison to the official carrier channels. In general, the European market is far more open to alternative distribution than the U.S. market. Everyone in the value chain, except carriers, eagerly waits for the day when non-carrier channels become viable for mobile content.

The protracted value chain dictates the cash flow and thus developers should expect no royalties until six or seven months after the first game is sold.

The author suggests that OTA business model enables larger circulation, but on the other hand, the protracted value chain with the significant power of carriers and game publishers leads to limited margins to game developers.

6.2 Mobile gambling

With the recent internet gambling boom various companies are taking advantage of the mobile market to attract customers. “The traditional methods of gambling such as casino gaming, betting on sports events and playing lottery games are increasingly being augmented with electronic forms of gambling, most notably using the internet, where casino services (such as www.888.com) and betting services (such as www.williamhill.co.uk) are already generating substantial revenues. The next progression in this process is to transfer these and similar services to the mobile handset”. (Juniper Research 2005).

The advantages of using the mobile phone as a platform for gambling application, including anywhere/anytime availability, are tempered by market constraints, such as regulation, social acceptability and getting robust user controls in place. The initial development in some markets is likely to see mobile becoming an additional channel for existing gamblers. In the longer term, the market will attract a significant number of new users as the inherent advantages of the mobile channel become apparent and as mobile gambling develops into a mass-market application. Consumers may not have access to their fixed Internet connection but they will almost certainly have their phone with them. This is why it's such a compelling application platform for casual games and gambling. (Juniper Research 2005)

The Asia Pacific region is expected to take $8.8bn (£4.62bn) in revenue by 2011, through a combination of casino, lottery and betting services. Europe will follow closely, taking $7.9bn (£4.15bn), while others fall behind. Juniper credits the speed of advancing mobile technology for the predicted boom (Juniper Research 2006). However, due to recent gambling-related legislation changes in the US, forecasts have dropped significantly. Although there is the possiblity that the point may soon be reconsidered: The World Trade Organization has ruled that the U.S. law violates international trade agreements.

The author states that gambling on mobile phones seems like a sustaining innovation to online gambling companies, but can be a significant extension to their business models. The value chain is likely the mobile equivalent of OTI (Over The Internet) value chain serving PC users. Thus, game developers may be treated purely as software developers with almost a commodity-like product and very little negotiating power while the profits go to online gambling companies.

6.3 Mobile Content In-game Advertising

In-game advertising and product placement integrates branding directly into the gaming environment. Advertising in mobile games can be an effective marketing tool. In-game advertising mainly focuses on the pushed banner-like ads in the absence of crucial, time and location-sensitive information.

6.3.1 Interactive Marketing in Location-Based Gaming Environment

Mobile devices allow highly targeted, flexible, and dynamic wireless advertisings. Location-aware technologies such as Cell Identification and GPS (Global Positioning System) have inspired to develop location-based games. Wireless gaming offers opportunities for local or customized ads and the ability to pinpoint the target market audience by placing the brand within a relavant game. In addition, advertising in downloadable cell-phone games is more cost-effective than running ads in traditional expensive advertising media such as magazines and TV. The location-based games may also drive people to stores in progress of the game. (Sang-Yeal Han, Moon-Kyo Cho and Mun-Kee Cho, 2005)

The author agrees that there may be some business potential in acting as an intermediary between consumers and sponsors. Sang-Yeal Han, Moon-Kyo Cho and Mun-Kee Choi (2005) proposed an intermediary "to provide time and location-relevant and proper volumes of commercial messages with incentives to consumers on the interactive location-based game for gaming pleasure and by providing monthly reports to track the impact to sales effect for sponsors. "
The mobile client with location-aware capability guides the consumer to collect items such as coupons and visit real participating stores by letting the user know the location information of itmes and the stores. This form of distribution of marketing can be very effective in mobile information. This type of marketing is private, flexible, context-aware, and gives control of the nature of advertising information where users can specify the frequency and value of the items (Han, Cho and Cho 2005). The author states that network externalities are of essence in this business model.

6.4 Subscription Model/Selling Software as a Service

Subscription model is the alternative to paying a flat fee: instead, consumers subscribe to, for example, a monthly scheme of payments (Pelkonen, 2004) for either limited or unlimited use. Subscription model has been categorized as a billing model (IGDA, 2005), but can be categorized as a business model, too. The author is suggesting that generally speaking, from the game developer's point of view, subscription is a billing model unless the game developer is selling the game as a service directly to consumers as in the case of some online role-playing games on PC. Subscription is more likely to be a business model for intermediaries between the game developer and consumers. However, if the game developer acts also as the distribution and sales channel to the end-user and has the required critical mass of games, then subscription may be considered as a business model.

The author categorizes the in-game per play/time/level payment business model proposed by Hendrik H. Heimer in IDATE Game Forum 2005 to the business model of selling software as a service. The business model could attract game developers' interest since there would be direct billing through mobile payment systems, and no payment through carrier or PremiumSMS (Heimer 2005.

6.5 Developer and User Generated Content

Another business model proposed by Hendrik H. Himmer in 2005 was "micropayment for game items" that is familiar from the PC multiplayer role-playing market. The author suggests that hand-helds could be another channel to existing PC RPG games, but taking into account the current limitations of hand-helds, this is not going to happen soon. However, RPG specifically developed for mobile multiplaying in which users are paying for in-game content may be a working business model.

6.6 Retail

Mobile games can be distributed, advertised and sold through retailers in a similar way as PC or console games. Nokia's N-Gage games use also retail as a distribution channel. These "rich games" are developed for Nokia's N-Gage mobile game deck and are supplied in the form of 8 MB (or larger) memory cards. The games are distributed also through other channels. They can be downloaded over the air (www.n-gage.com). The author suggests that with the advent of 3G and other fast network technologies, the need for retail may have decreased, although customers may still prefer to buy something concrete.

PC game developers often prefer to use game publishers that take care of marketing and distribution. The author suggests that as most mobile game developers have even less resources than PC game developers, the effort of doing one's own marketing and distribution to a global market may be overwhelming. Merely creating and managing the distribution channels to retail could be extremely burdensome, not to speak of reaching consumers. Thus, the author suggests that for game developers, retail is more a distribution and marketing channel than a business model.

6.7 About Value Chains in general

As devices reach critical mass, new entrants will be attracted to the market and channels such as print media, independent portals and interactive television will provide marketing focus. These channels focus only on a single application and are better able to create awareness. To drive usage, the features of mobile gaming products have to be clearly advertised and marketed to a wide audience. However, because of the nature of the product, there is no single medium that provides a complete solution to vendors' promotional needs. The handset itself can be used as a marketing tool, by targeting users with screenshots through WAP links or multimedia messaging service messages. The small windows of the device and the inability to send adequate information about the games are holding this medium back. One of the strengths of mobile gaming is that its marketing campaigns can be integrated with other campaigns, in particular for film and console games. The print media is ideal for advertising a range of logos and ringtones on a single page, while television can be used to show gameplay in great detail. Interactive TV and the Web are excellent media for offering a variety of games and demonstrations. Even so, the lack of animation in print media, the high costs of television advertising and limited penetration of interactive television could prove to be dampeners. (Frost & Sullivan 2003)

One major problem for developers and publishers of mobile games is describing a game in such detail that it gives the customer enough information to make a purchasing decision. Currently, mobile games are mainly sold through network carriers or operator's portals and this means there are only a few lines of text and perhaps a screenshot of the game to excite the customer. Two strategies are followed by developers and publishers to combat this lack of purchasing information, firstly there is a reliance on powerful brands and licenses that impart a suggestion of quality to the game such as Tomb Raider or Colin McRae and secondly there is the use of well known and established play patterns (game play mechanics that are instantly recognizable) such as Tetris, Space Invaders or Poker. Both these strategies are used to decrease the perceived level of risk that the customer feels when choosing a game to download from the carrier's deck. (wikipedia: mobile game)

6.8 Conclusions

Examining all the current and potential business models above, one can see that most of them are more or less familiar from the PC space. As last but not least, the author suggests trying to downsize any concept that has worked or even failed in the PC or console space to mobile phones and hoping that it will fly.

7. Forecast

Juniper research predicted mobile gaming to be a market of $23 billion by 2011 (Juniper Research, May 2006). Later in 2006 Jupiter Research forecasted the global market for mobile gambling to grow from $1.35bn (pound 684.4m) in 2006 to $16.6bn (pound 8.42bn) in five years' time. The changed prediction forms part of Jupiter's return look at the sector in light of strengthened legal barriers in the US. As a result of the legislation, US forecasts have dropped considerably, allowing Europe and Asia-Pacific to dominate (New Media Age, Jan 25, 2007, pp. 13).

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http://www.tml.tkk.fi/Opinnot/T-109.551/2003/

Appendix A: Investments and Acquisitions

Equity investments in 2004 (IGDA 2005):

Date	Company	Funding ($MM)	Investors
Nov-04	Digital Bridges	$18	Apax, Argo
Aug-04	Mforma	$19	Draper
Aug-04	Digital	$13	Sutter Hill
Aug-04	In-fusio	$27	Insight Ventures
Jul-04	Sorrent	$20	BA Ventures
May-05	Sorrent	$20	Granite Global

Acquisitions:

Date	Company	Funding ($MM)	Investors
Dec-04	Elkware	$26	InfoSpace
Aug-04	IOMO	$15	InfoSpace
Mar-05	Stadeon	Not Reported	Yahoo
Sep-04	Digital Red	Not Reported	Shanda
Aug-04	Jippi Mobile	Not Reported	iTouch
Aug-04	Blue Beck	Not Reported	Mforma
Aug-04	FingerTwitch	Not Reported	Mforma
July-04	Atlas Mobile	Not Reported	InfoSpace
June-04	Sumea	Not Reported	Digital Chocolate

FIXED MOBILE CONVERGENCE

Johanna Heinonen
Helsinki University of Technology

Abstract

Fixed mobile convergence (FMC) means that fixed and wireless networks will merge and end users are able to get the same services no matter which access technology or terminal device they use. FMC is an opportunity for different types of operators. They get some new ways to get revenue from their existing networks and possibly new types of subscribers because of the large variety of access technologies.

For end users FMC brings easiness to use all services via best available access network with one terminal. The target is also to charge all services with one bill. Examples about the services are voice over IP (VoIP), presence, push-to-talk, instant messaging and interactive gaming.

The core of the FMC architecture is 3GPP standardized IP multimedia subsystem IMS together with IETF session initiation protocol SIP.

Key Words
Convergence, IMS, SIP

1. Introduction

There are different kinds of access operators in the market: fixed operators, mobile operators, hybrid operators and mobile virtual network operators MVNOs. Fixed network operators operate fixed wireline networks, mobile operators have 2G/3G mobile networks, hybrid operators operate both wireline and wireless networks and MVNOs utilize three other types of operators' networks to provide their services. All of those have realized that the competition in the market becomes more and more tough and the revenues are getting smaller or coming close to zero. Fixed operators realize that their subscribers have a tendency to replace their fixed phones with a mobile phone and mobile operators are lacking high bandwidth that the fixed operators can offer to their subscribers. Therefore new strategies and business opportunities are needed. One good possibility is fixed mobile convergence.

For MVNOs fixed mobile convergence makes it possible to utilize both fixed and mobile operators' networks. This means that MVNOs can offer services to end users in a more flexible and efficient way. Mobile operators can enhance their network coverage for example by using unlicensed mobile access / generic access network UMA/GAN technology which means higher data rates inside the buildings over wireless LAN and handovers to GSM or 3G networks when needed. Hybrid operators can reduce their costs by optimizing their networks. Fixed operators can co-operate with mobile operators or enlarge their coverage towards mobile access by using multi radio terminals with WLAN access or UMA.

Chapter 2 presents the overview of fixed mobile convergence. Chapter 3 covers the main standardization bodies related to FMC and tells the main standardization area of each. FMC network architecture and examples about the call cases are presented in chapter 4. Chapter 5 covers end user services related to fixed mobile convergence. Chapter 6 concentrates on effects to operator business models and vendor strategies. FMC challenges are introduced in chapter 7 and chapter 8 contains the conclusions.

2. Overview of Fixed Mobile Convergence

The concept of fixed mobile converge is not anything new. It was introduced already in 1990's. However at that time the technology was not mature enough and there were no unified standards. There were neither proper terminals nor appropriate market business drivers. At that time FMC strategies were based for example on intelligent network platform that supports both fixed and mobile users (Vrdoljak 2000, Ciannetta 1999). Nowadays intelligent network platform can be part of the fixed or mobile network where it implements a set of services but it is not the core of FMC implementation.

The target of fixed mobile convergence is to have all services seamlessly available from any network and with any terminal device. In practice this means device convergence, service and application convergence and network convergence. Device convergence means that one mobile device supports several access technologies and in addition to telephony some other functions such as camera or TV. Service convergence means that the same services can be provided to the user over different access networks and to different devices. Network convergence gives the possibility to access the core network and services via different access technologies.

Separate wireless, wireline and data networks will merge and it is possible to access to the unified core network via different access technologies. Using common technologies and common services in the fixed and mobile networks end users can reach all services with the same terminal. 3rd Generation Partnership Project 3GPP specified IMS architecture and Internet Engineering Task Force IETF SIP protocol are the main building blocks in this architecture. IMS is the core of the fixed mobile convergence architecture. IMS handles the SIP sessions between terminals. GPRS and 3G networks are offering data connections to the network servers but IMS gives the possibility to have mobile to mobile sessions. Application servers behind the IMS are offering services like push-to-talk and presence. The logic and the concepts related to the IMS architecture are presented by Poikselkä. (Poikselkä 2006).

One difficult aspect in FMC is how to enable a set of new services so that they work in every location, with any access technology and terminal device. Especially seamless handovers from one access network to another are a challenge. Common standards play a key role in FMC because otherwise equipments from different vendors are incompatible which makes it difficult to reach the main target: same services available no matter the network and access technology.

3. Status of Related Standards

Fixed mobile convergence merges different types of networks. This means that lots of protocols and different types of architectures are involved. It is thus essential to the vendors, operators and finally also to the end users to have common standards related to FMC. Otherwise interoperability problems prevent the efficient use of network resources.

The main standardization bodies related to FMC are 3[rd] Generation Partnership Project 3GPP and Internet engineering task force IETF. 3GPP have defined SIP-based IP multimedia subsystem for telephony and other services (3GPP). It is based on IETF work with some extensions. The core IMS architecture was introduced in 3GPP release 5. Release 6 adds some improvements to this architecture such as CS-IMS interworking. Circuit switched - IMS interworking makes it possible to set up a call between SIP client in IMS domain and a normal 3G mobile in circuit switched network. Also UMA was introduced in release 6. 3GPP is continuing its work in release 7.

IETF is the main standardization body for internet protocols especially it is the originator of the SIP standards (IETF). Telecommunication and Internet converged Services and Protocols for Advanced Networking TISPAN is the European Telecommunications Standards Institute ETSI core competence centre for fixed networks. TISPAN is specifying IP and SIP-based next generation networks NGN architecture based on 3GPP IMS release 6 (TISPAN). Open Mobile alliance OMA is working on SIP-based services which are used on top of IMS (OMA). Examples of these applications are Push-to-talk and presence.

4. FMC Network Architecture

Figure 1 shows a simple FMC network architecture. In this example the IMS is connected to access network via session border controller, Push-to-talk application server and to the MSC server which makes CS-IMS interworking possible. FMC makes it possible to have SIP sessions between different kinds of terminal devices. These SIP sessions can include VoIP, video sharing, gaming, messaging etc.

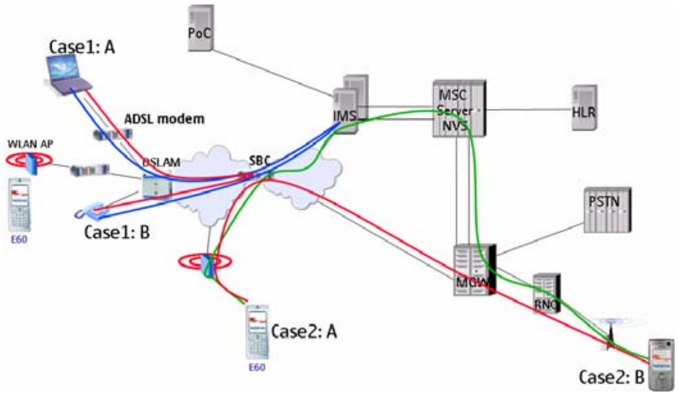

Fig 1. FMC network architecture.

In figure 1 there is two call cases presented. In case number 1 SIP client in a PC makes a voice call to plain old telephone service POTS phone. Before the SIP session can be established both the PC client and POTS phone have to register themselves to the IMS. SIP client in the PC can do it by itself but in case of the POTS phone the POTS card in Digital subscriber line access multiplexer DSLAM (e.g. Nokia D500) does the registration of behalf of the POTS phone. When PC client initiates a VoIP call towards the POTS phone the SIP invite message is sent to the IMS. The logical function that handles the session control in IMS is called call state control function (CSCF). P-CSCF is the logical entity which IP address has to be known by the mobile. I-CSCF is the interrogating CSCF and S-CSCF is a SIP-server that controls the services of the users. When the SIP session has been set up between the users the actual speech packets are routed using normal IP routing, these packets do not go through the IMS.

In case number 2 a multi radio terminal is registered to IMS via WLAN access point. The other terminal has made a location update to the mobile switching center server MSS via 3G radio access network. When the call is set up the SIP invite goes first to IMS which routes the call to the MSC server. MSC server realizes that subscriber B is in its visitor location register VLR database and starts normal paging procedure. When the session is setup A and B can start the conversation and possibly add to the session other elements like messaging or video. Table 1 presents the main elements of the FMC implementation.

Because IMS is the centralized point in the convergence network it is possible to share some resources regardless of the service or access type. These resources include for example charging, presence, group and list functions, provisioning, session control and operation and management (Kataria, 2005).

Table 1. FMC network elements.

	Elements
FMC Core (IMS):	**HSS**, Home subscriber register, permanent storage for IMS subscriptions **P-CSCF** is a SIP-proxy that proxies SIP-messages between user equipment and other CSCFs **I-CSCF** queries HSS for user registration status or S-CSCF information **S-CSCF** authenticates the user and forwards the requests to the application servers
Access technologies:	
GPRS/3G networks	**SGSN** - serving GPRS support node **GGSN** - Gateway GPRS support node
UMA	**UNC** - UMA network controller
Broadband access, WLAN	**DSLAM -** Digital subscriber line access multiplexer **DSL modem** **WLAN access point**
Application server examples:	Push-to-Talk server Presence server

5. End User Services

End users want the price and quality of fixed wireline and the convenience of mobile wireless. For end users FMC means the possibility to have one terminal which is capable of handling all the needed access technologies and services. Also all the services can be charged with one bill.

Fixed mobile convergence association FMCA is an alliance of telecom operators whose objective is to accelerate the development of convergence products and services. FMCA has listed convergence service scenarios (FMCA). Here are the most important ones:

1. **Converged contacts** is a service that provides personal contacts and address book in the network-based storage. This storage should be accessible from any device and the terminal is able to synchronize the local address book based on information from central network-based storage.
2. **Personal multimedia** provides secure access to the user's multimedia content that is stored in home or in the network from any device.
3. **Multimedia call with data sharing service** makes it possible for the user to switch between voice only GSM call and multimedia call containing e.g. picture or broadband-enabled TV. The service automatically detects which kinds of networks are available.
4. **Combinatorial services** are based on availability of multiple connections (circuit and data) during the same communication session. For example it is possible to add to the voice call messaging (SMS/MMS/IM), video streaming and one or more data flows (file sharing).
5. **Electronic Programme Guide service** is listing available programmes that can be watched on the mobile device or recorded on video recorder.
6. **Automation control and monitoring service** makes it possible to control various home based tasks via the mobile device such as temperature and access.
7. **Convergent call control** provides the ability to automatically handle the call based on some events. For example based on the information of the user's electronic calendar, the location of the user and the importance of the caller the call will be connected to the user or to the voice mail etc.
8. **Multimodal services** include several scenarios where voice and data sessions are mixed.

In addition to VoIP calls other services commercially available for end users are for example video sharing and instant messaging. Presence service enriches other applications, for instance push-to-talk service benefits if the user can see from the contact list who are available for group talk. Interactive gaming and chat give nice entertainment for users.

Though IMS gives the possibility to have all above mentioned services most probably voice remains the most widely used service in fixed and mobile networks. Voice is an example of convergent service because it can be offered across both networks (Kataria 2005). Some other services such as SMS and instant messaging are associated with a specific network. To be able to send a text message from SIP client to 3G mobile a conversion from instant message to SMS is needed. The target is to introduce new services in a transparent way over both types of networks.

6. Influence to Operator Business Models and Vendor Strategies

End users expect from operators simplicity of services, simplified charging and quality. FMC is one possibility to get closer to these targets. With FMC the end users are connected to the service always via the best possible access network and they can use the same set of services by using the same terminal device. The challenge for operators is to provide feature consistency across different kinds of networks both wireline and wireless. Also broader coverage is needed.

For operators the FMC means possibilities to remain competitive, differentiate themselves from others and opportunity to grow into the new areas which can mean new different type of customers and revenue opportunities. In general FMC offers two main benefits to the operators: interoperability and reduction of the costs because common resources can be used.

FMC is a way for mobile operators to access fixed network. This means a threat for fixed operators who have to develop new strategies. Cellular markets in many industrial countries are almost saturated and therefore also mobile operators have to find new revenue opportunities. Trying to get more subscribers does not work any more. The existing subscribers should increase their usage of services which leads to the conclusion that new attractive services are needed.

Seamless roaming from one access technology to another is essential. Handsets (multi radio terminals) capable of handling several access technologies will have a key role.

Inter working with existing networks is very important. When operators are developing their networks towards FMC the solutions must be adjusted to each operator. Also regulations might be different in different countries.

Ficora has made a report (Ficora 2006) about the investment plans of the Finnish operators in the near future. The report tells that the amount of investments is going to increase because of the equipment needed for convergence and next generation networks. On the other hand the operators believe that they will get remarkable cost savings by using IP based techniques. Also they believe that convergence will bring new services for end users.

Like many other emerging industries FMC is a continuously changing and complex environment which creates uncertainties at technology, demand and strategy levels (Wong 2006). The technological uncertainties are caused by rapid technological development and the developing standards. Despite the fact that there is a general understanding about the huge potential of FMC there are many open questions related to the new services. What are the services that the users are willing to pay will be seen in the future. All these questions cause uncertainty in demand level. Strategic uncertainties are common to all emerging industries. A clear framework is needed to prevent the operators to do costly mistakes by entering and subsequently exiting non-core businesses and markets.

FMC applications can be segmented in two markets: consumer and business. In general consumers want to be entertained and communicate with friends and family. Business users on the other hand need good connections and high bandwidth. Enterprises invest a lot to enterprise communications systems (PBX).

The fact that operators want to reuse their existing networks has to be taken into account by vendors. Many vendors have different kinds of evolution paths and step-by-step network introduction to the FMC and all IP networks. UMA solution is offered by many vendors to access the network over WLAN. Then the main solution is based on IMS. Seamless roaming and availability of services are key messages to the operators. Vendors have realized that standardization is a key issue if they want to provide solutions that can be integrated to the equipment of other vendors. Most of the vendors have taken an active role in many standardization bodies.

7. FMC Challenges

Nowadays there are clear strategies how to implement FMC. Several standardization bodies concentrate on the related standards and there are already some attractive end user services available. Still FMC is facing some challenges that need to be solved (Safavian, 2006).

1. Number plans and number portability. Fixed and mobile numbers come from separate blocks and they have prefixes that contain information for interconnection charging. Currently there is separate fixed number portability and mobile number portability available but not fixed/mobile number portability.

2. Directory services. Fixed operators provide directory service to their customers. This catalogue contains information on all fixed line customers. Currently mobile operators do not offer this kind of service and mobile numbers are considered as personal data.

3. Handset availability is always a problem in the early stages of any telecommunications technology.

4. Role of regulators. There are two opposite views about the role of regulators in FMC. One point of view is that it is not a task of regulators to decide the rules for FMC. Regulators should only set up the environment so that the market forces can guide direction, extent and pace of FMC. Another point of view is that since the definitions of information, data and entertainment has changed the rules related to network and service providers should change accordingly.

8. Conclusion

FMC gives lots of possibilities but on the other hand it means also new investments to operators. Common standards have a great importance. Without standardization the equipment of different vendors cannot be integrated together and operators cannot utilize their networks in the best possible way.

Standardization work is still going on. A question is also how much the end users are willing to pay for the services. For example many users think that VoIP services should be free of charge. This is due to the fact that for example with skype the users can already have free VoIP calls in the Internet.

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BUSINESS MODELS FOR MOBILE MUSIC IN FINLAND

Jussi Uusi-Hakala
Helsinki University of Technology, Network Laboratory
P. O. Box 3000, FI-02015 TKK, Finland
juusihak@cc.hut.fi

Abstract

The turnover of digital music has almost doubled worldwide in 2006 (IFPI 2007). Although the same growth figure is less moderate in Finland, the number of online music stores has increased rapidly. At the moment, there are nineteen electronic music retailers in Finland (pro-music.org 2007). Recent development, on network data transfer capacity and mobile handset, has opened a way for mobile music business. Digital music can be downloaded over the air and listen with one single mobile device. Base on a literature study and continuous monitoring of the industry, this paper aims to developed holistic picture of mobile music field in Finland. Moreover, several business models for mobile music are discussed.

Key Words
Business Models, Finland, Mobile Music, Music Trade

1. Introduction

Popularity of portable digital music players, like Apples iPod, have increased enormously during this decade. Broadband network connections have become common which have made fast download of digital music available for many. In addition, buying music on digital format is much cheaper than on traditional formats. These trends have created an immense growth for digital music. (IFPI/M-LAB Survey 2007).

Data transfer capacity of third generation mobile networks has increased dramatically. Depending on radio technology and an environment, data transfer speed can reach several megabits per second. These rates enable download times for full length digital music tracks that consumers can tolerate. After linked transaction of 3G mobile phones was allowed 1.4.2006 in Finland, the demand for these devices has surged. According to Finnish Communication Regulatory authority (2006), 40 percent of all mobile phones sold during second quarter of 2006 had 3G capability. Moreover, most of these mobiles have ability to play digital music.

Currently, most of digital music is bought from online music stores, like iTunes or eMusic. Consumers must use their PCs or laptops to access these stores, download a song to PC's hard drive, after which the music can be transferred to a portable music player. When a mobile phone is used as a digital music player, a user can download music over the air (OTA) directly to mobile device. Moreover, a consumer always carries his phone, and more importantly a music purchase can be initiated wherever a network capacity is adequate. However, over the air music trade does not exclude possibility that full-length songs could be first downloaded to a computer after which they are transferred to mobile device. Therefore, mobile music should be understood more holistically as a purchase of digital music to mobile phone rather than just OTA trade of digital songs. This approach for mobile music is used throughout this paper.

This study aims to analyze mobile music business in general but the focus is Finnish digital music markets. This paper tackles issues like digital right management (DRM), role of mobile device manufacturers, technological development, and competition from dedicated portable music players. Mobile music enables several possible business models. These models are described on the last section.

2. Situation Overview

Until now dedicated portable music players have dominated markets. But things are about to change. Mobile phone manufactures have incentive to add music features to their products to boost their sales. An estimated 27% of the mobile phones sold globally in 2006 will be able to store and play music. By 2010, the number is estimated to be 69% (Ewing 2006). In addition, Operators are pushing mobile music forward. Their incentive is to create services which could utilize existing third generation networks. What additional value a consumer can get by using mobile phones as a main music player? This section also examines technical features, which differentiate mobile phone and dedicated portable music player, and the role of digital rights management. Finally, the main reasons why mobile music business is not booming are discussed.

2.1 Digital Rights Management in 2007

DRM (Digital Rights Management) is software or a technique which restrict a user to transfer digital music content. For example, when a customer buys a track from iTunes, the track can only be played on Apple's music player software or portable device iPod. DRM was created by the four biggest record labels (Sony

BMG, EMI, UNIVERSAL, and WARNER) to protect their copyrights. However, CDs are not DRM protected which means that music can be freely transferred from CD to mobile phone. DRM hinders digital music trade because a customer cannot play the same music file on different manufacturer's device (Talbot 2007). This means that only way to legally purchase digital music to mobile phone is to download music over the air.

However, as the online digital music trade grows, owners of the largest music stores, like iTunes' Steve Jobs, are now demanding DRM-free downloads (Raby 2007). According to The Wall Street Journal, EMI has began to campaign to allow its music online without DRM protection (Raby 2007). Mobile music business definitely benefit from dismantlement of DRM because consumers could freely download and transfer a music file regardless of the distribution medium. Moreover, interoperability would increase i.e. digital music could be transmitted from mobile phone to different devices like computer or stereo system.

2.2 Technical Features of Digital Music Players

In 2001 Nokia introduced the first mobile phone which could play digital music. The phone weighted 155 grams and monochromic display showed five lines. It had 64 MB memory and optimal playback was 10 hours. At the same year Apple launched the first version of iPod which was a portable music player. Because the device was only dedicated to play digital music, iPod had features like innovative user interface, 5-10 GB memory. Moreover, iPod users could legally purchase tracks form Apple's online music store iTunes, whereas owners of Nokia's 5510 could only transfer music files from CDs. After iPod was launch in 2001, it became the most popular portable music player. Currently, different versions of iPod account for 75 percent of digital music players markets, according to the NPD Group (Lee 2006). Because iPod dominates the market, this text uses the device as the benchmark of a portable music player. One way of gauging mobile music feasibility is to compare mobile phone's and iPod's features against each other.

Memory capacity, that is adequate for storing digital music, does not significantly differ between dedicated portable music player and mobile phone. Apple has launched several adoptions of iPod. The memory capacity of these products varies between 1 GB and 80 GB. Mobile phones have typically much smaller inbuilt memory. For example, a Nokia N73 music edition has 42 MB of shared memory. However, music phones have separate slot for memory card which enable to increase storage capacity to several gigabytes. The NPD group found in a survey that in the first quarter of 2006 the percentage of cellphones sold with removable memory slot was 6 percent (Palanchar 2006). The survey was conducted in U.S. markets but the most import information was that sales of memory-card-capable handsets rose 250 percent in one year. In addition, more and more mainstream model have the feature. A study also predicts that by 2009 nearly 70 percent of handsets will have memory slots (Kuhl 2007). To conclude mobile phones have the same capability to store music as dedicated portable music players. The more spacious hard disk drives are intended to video storage not music. For example, 1 GB of memory is equivalent to 240 full length songs which is enough for majority of people.

Portable music players outperform mobile phones in terms music play time. For example, Nokia's music phone N91 can play music up to 10 hours (Nokia 2007), whereas, music playback time for iPod video 30 GB is 14 hours and 24 hours for iPod nano (Apple 2007). The battery life information is gathered from manufacture's official website. The figures represent playback time on an optimal environment so actual battery life may be somewhat different. Although dedicated devices have better batteries, it does not necessary mean that mobile phones have bad music playback time. If a user has an opportunity to charge the device daily, 10 hours of music playback time is adequate. However, battery life may become an issue, if charging possibility does not exist. For example, this may be the case on a long distance flight.

Current network capacity enables fast over the air transfer of music. In 3G/WCDMA mode download speed can go from 384 kbits/s to 2 Mbits/s and respectively in EDGE mode to 220 kbits/s (Frenzel 2005). In these data transfer rates, full-length track can be downloaded in an optimal environment in less than a minute. 3G phones gain popularity in Finland According to Finnish Communication Regulatory authority (2006), 40 percent of all mobile phones sold during second quarter of 2006 had 3G capability. In the near future device manufacturers release mobile phones, like Nokia N95 or Nokia N93i, which can achieve even faster data transfer rates. These phones have inbuilt WLAN function. Some WLAN standards like 802.11b supports 5 Mbits/s or hyperlan2/802.11a promises 32 Mbits/s transfer speed. With these rates music download time is close to the wired Internet.

2.3 Special Features of Mobile Music

Mobile phones have an important advantage over dedicated portable digital music players – Mobility. Music is often an impulse purchase and mobile music can be downloaded immediately after the experience event that initiated the purchase took place (Grech and Luukanen 2005). For example, if a listener hears a song from a radio, he can instantly acquire the song to his mobile. Sony Ericsson already sells technology allowing users to record part of a song and instantly gets information about the artist (Ewing 2006). Though DRM techniques prevent copying music from mobile to PC, music providers, like Elisa's Jukeboksi or Musiikkilataamo, allow with single payment to download the same song over the air and over the fixed Internet.

In addition to playing music, smart mobile phones can perform many other functions. A user needs only one device to browse the Internet, read e-mail or take pictures. And the number of people who are using smartphones is increasing rapidly. Allowing of linked transaction, in Finland 2006, has increased the annual sales of smartphones from 168 000 to 367 000. Moreover, during the same period over million sold mobile phone had mp3-player (Kauhanen 2007). It is much more convenient to carry only one music device than pack both mobile phone and separate portable music player into one pocket. A phone needs to be carried anyway, so why bear another music player? People have also got used to download ring tones and other digital content to their mobile phone so there is not a big step to start using mobile music.

2.4 Service Pricing and Usability

Usability of music player is difficult to measure because easiness to use is experienced subjectively. Instead, some objective criteria, like display size or quality, can be use as a measurement. Display quality matters because a larger screen enables to see more lines at single glance. There is not big difference of screen size between mobile phone and dedicated music player. For example, the resolution of Nokia N73 display is 240x320 pixels and it can show 262 144 colors compared to iPod Video's display which has 320x132 resolution and 65000 colors. Many mobile phones have already dedicated buttons, which can be used to manage music player software. However, in addition to playing music, cell phone is always designed to perform other function, like typing messages. Where as the control mechanism of dedicated devices are optimized only for playing music

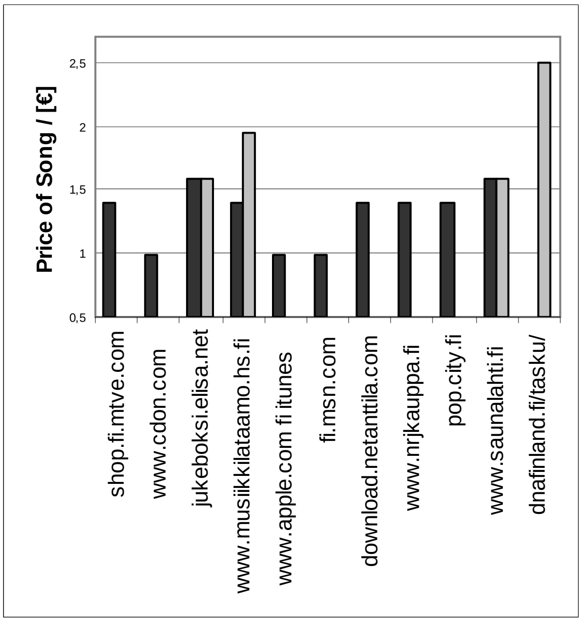
Dedicated portable music player and mobile phones do not have any major technical features which would make one device more superior to another. However, there are major differences on music management and pricing. It is very difficult to synchronize music between a computer and a mobile phone. For example on Elisa's music store, a song is first downloaded to mobile but a heavy user involvement is required if a consumer wants to play the same song on his computer. Another synchronizing problem arises when a user wants to download music from the fixed Internet. Due to DRM protections, different online music stores' files are only compatible with limited number of mobile phones. Sometimes transferring music from CDs might be the only legal way to acquire songs to mobile phone. On the other hand, dedicated portable music players have the same problem.

To avoid the synchronizing problem Apple has created a strong link between the portable device, iPod, and the music store, iTunes. Apple launched its music manager and music store software iTunes in 2001. Since then the firm has further develop the program which makes the user interface intuitive and very easy to use. All the bugs are fixed and synchronizing is very fast. It is hard to gauge, how much interoperability of a computer and a music player, and the usability of music manager software affect the feasibility of the mobile music business but it has certainly some importance.

What is the correct pricing for digital song? Table 1 illustrates different price points that Finnish online music stores have set for digital songs. Some retailers, like Musiikkilataamo or Saunalahti, offer a possibility to transfer wirelessly full length music. The grey columns refer to price of over the air downloads. The figure clearly shows that consumers have to pay premium to get their songs delivered wirelessly. When digital music is bought from Apple's iTunes or Microsoft's music store, one track costs 0,99 euros. But if a customer wants to download tracks directly to his mobile phone, he has to pay at least 60 cent premium per song price and on top data transfer fees.

According research firm International Data Corp (IDC), users are willing to pay even double price for over the air music, if mobile storefronts are well-designed and offer a wide selection of music, and the music listening experience on the device is comparable to MP3-players (Electronic News 2006).

Table 1. Finnish online music stores' pricing for a full length song. Grey column indicates price for over the air download when this service is available.



3. Possible Business Models

Mobile music offers business opportunities for several actors in mobile ecosystem. This section examines three business strategies for mobile music and the role of different player in each model. Vlachos, Vrechopoulos, and Pateli (2006) recognize two business models for mobile music distribution. In their first scenario, a brand retailer has the dominant role serving mobile music. On the other, a mobile network operator creates its own brand through which the music is distributed. In addition to Vlachos', Vrechopoulos', and Pateli's model, another scene is emerging. Several mobile device manufacturers have announced that they would open their own mobile music store. Table 2. illustrates every online music store in Finland, according to pro-music.org. On the table 2 every music store is categorized based on Vlachos', Vrechopoulos', and Pateli's model.

In principle, digital music delivery business may seem very lucrative. Fixed costs are small compared to other industries because only server and product development is needed to open an online music store. Moreover, the product is in digital form so production of additional unit does not cost anything and a company does not have to maintain any inventory. However, because entry barriers are so low new players can easily enter to industry. Currently, there are over nineteen online music stores in Finland. Due to this development, content providers have strong bargain power. For example, according to David Card at Jupiter Research, Apple has to compensate music right holders with a fixed 70 percentage of every sold song (Helm 2005) Digital music price cannot be too high. Otherwise even bigger proportion of people would acquire songs by illegal means. This means that margins are very low in the mobile music business.

3.1 The Brand Retailer Mobile Music Business Model

This means that the mobile music service offered by a branded content retailers will be the one with which the music customer will interact. Typically, branded retailer is part of other media company or music store is founded on bases of another business. A branded music store might be founded to boost the sales of the main product, like MaxMusic, or it can be part of service portfolio, like Netanttila. Competitive advantage for an online music store can come from resources that the mother company posses. For example, NRJ Kauppa is owned by radio station NRJ Finland in which case the music store gets free promotion on radio. Currently, only Musiikkilataamo offers a possibility to download music over the air directly to mobile phone. However, branded music stores may easily alter their service so that music can be downloaded over the air. In this model, a network operator only transfers the digital music and a manufacturer produces handsets which are capable of playing music. Music provider may take more active role as a music distributor, especially if DRM protection is removed.

3.2 The Network Operator Mobile Music Business Model

On the other model mobile music service is solely offered by a mobile network operator which uses its own channels for distribution. An operator creates own brand and marketing strategy. Currently, with the exception of TeliaSonera, every major Finnish network operator has its own music store. The Music store might be part of overall service offer, which includes also subscription and a mobile device. Operators' competitive advantage comes from their ability to integrate music store to handset. Moreover, billing is more efficient because a music purchase can be added to buyer's subscription bill.

3.3 The Mobile Device Manufacturer Dominated Business Model

In this case, device manufacturer takes more dominant role on mobile music distribution. Customers have to use manufacture specific distribution channel. For example, iPod's users can only access online music through Apple's music store iTunes. Moreover, a manufacturer creates own brand which can be directly associated to its handset. In this scheme a network operator has bigger role than brand retailer business model. Operators are the major retailer sellers of mobile devices and manufacturers might be reluctant to enter content service business that traditionally belongs to mobile network operator. For example, Nokia has announced that the company is going to open a music store in some collaboration with an operator (Lassila 2007).

Table 2. Digital music etailers in Finland. Source pro-music.org.

Shop	Brand retailer	Network operator	Manufacturer	Over the air
shop.fi.mtve.com	X			
www.cdon.com	X			
jukeboksi.elisa.net		X		X
www.funman.fi	X			
www.emusic.com	X			
www.musiikkilataamo.hs.fi	X			X
www.apple.com.fi/itunes			X	
musiikkikauppa.lumonetti.fi	X			
www.maxmusic.fi	X			
www.mediamilkshake.fi	X			
fi.msn.com	X			
download.netanttila.com	X			
www.nrjkauppa.fi	X			
pop.city.fi	X			
www.musakauppa.saunalahti.fi		X		X
musiikki.welho.fi	X			
Nokia music store			X	(X)
Samsung music store			X	(X)
kampanja.dnafinland.fi/tasku		X		X

4. Conclusion

Dedicated portable music players have taught people consume digital music. However, if dedicated music devices cannot offer any significant additional value compared to mobile phones, people have no incentive to carry two separate music players. Table 1 shows that over the air music costs more than downloading music from the fixed Internet. Are customers ready to pay this price premium? Many service providers, like Elisa, Saunalahti or Musiikkilataamo, like to think so. They believe that a music consumer wants to download music wherever he is, and whenever he likes. The second issue is usability of mobile music players. If music distributors can offer a service which is easy to use and enable effortless synchronize with a computer, over the air music may become the next killer application. Study from IFPI/M-Lab (2007) showed that about 10 per cent of portable music player owners used a mobile device as main music player. However, this does not automatically mean, that every member of this group is willing to buy mobile music or any legal digital music.

According to IFPI Finland, the number of music downloads totaled 572 120 from January to October in 2006. During that period unit sales rose 22 % from corresponding period last year. Though the market size is rapidly increasing, there are many players sharing the revenues. Is the mobile music going to be genuine business, or a low margin service? Online piracy is an issue that is not covered in this paper but affects significantly to pricing of digital music. The price point has to be low enough so that people would be willing to pay for digital music. Mobile network operators want to create a profitable data service which exploits existing 3G network infrastructure. On the other hand, manufacturers' incentive might be to sell digital music with loss or very low margin in order to create higher demand for their music player devices which generate most of the revenues. For example, Apple sells music with very margins so that people would buy more Apple's music players.

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MOBILE SOLUTIONS IN BUSINESS PROCESSES

Mikko Lipasti
Helsinki University of Technology
mikko.lipasti@tkk.fi

Tapio Schrey
Helsinki University of Technology
tapio.schrey@tkk.fi

Abstract

Developing technology is enabling new ways for mobile access to corporate information systems. A number of solutions already exist mainly in Sales-force automation (SFA) and Field-force automation (FFA). This paper analyses what kind of new applications exist and evaluates their end-user benefits. Also, an exploratory case study of small Finnish company using mobile solution for SFA and FFA is made.

Our results show that mobile business process solutions are already in use. Four kinds of benefits were identified: increased worker and process efficiency, higher process quality, financial savings and improved end-user morale and customer trust. The mobile solutions are, however still quite simple and task focused. We expect that the development of next years brings forward more massive business process remodelling and also new radical business solutions.

Key Words
Business processes; mobile, wireless technology, mobile information services, business benefits

INTRODUCTION

During the past ten to twenty years, a number of computer applications have been developed to support business processes (Rodina et al., 2003). Whilst information technology has an important role in business processes (Chan, 2000), being tied to the office computer has been limiting the possible uses (Rodina et al., 2003). Lately the development of mobile technologies has bought forward new applications for accessing corporate information systems. Significant advances in devices, networks and software (Wang et al., 2005) have been directing companies' attention to the opportunities that mobile solutions offer for their business processes (Chan, 2000; Sarvas, 2006).

Traditionally the mobile applications to business processes have been rather simple (Rangone & Renga, 2006) and task focused (Kar et al., 2006). The next generation mobile enterprise solutions are, however moving the focus from compiling simple tasks to enabling business processes (Kar et al., 2006). The aim of this study is to analyse what kind of new applications mobile access to corporate information systems enables, and to evaluate the expected business benefits for end-user organisations.

A number of definitions are offered for mobile devices in literature. For this study we consider mobile phones, smart phones and PDAs with GPRS or 3G capability (either natively or through externally) (Derballa & Poustthci, 2004; Rangone & Renga, 2006) . Whilst some studies include laptops into the definition of mobile devices, we follow the example of excluding them from the scope due their size (as Rangone & Renga, 2006) and special characteristics (as Derballa & Poustthci, 2004). Another scope definition we have made is to focus on access to enterprise applications and give limited attention to email and calendar applications in this study.

This research paper has been split into three main parts. The part I is a literature review in which we will describe the needs mobile applications are used to satisfy, outline the main fields such m-applications are currently used at, explore some of the end-user benefits and finally close by exploring some future development trends. In part II we will present a real life case study of a small Finnish company using WiseMaster mobile application for its field sales. Finally in the 3rd part we will offer the reader some key conclusions based on the literature and case study.

I LITERATURE REVIEW

1. Background

Mobile workforce is not a new concept, but has existed almost as long as workforce itself. Wang, van de Kar and Meijer (2005) define mobile workers as those people whose work-tasks can be only completed in a mobile environment. Such workers include for example salespersons on the field, travelling executives, workers on corporate yards and warehouses and people working at customers' sites.

These mobile workers work in a very different environment than office workers (Kar et al., 2006), but still have the need for the same corporate data that is available for 'normal' employees (Wang et al., 2005) in order to remain highly productive and efficient (Rodina et al., 2003). For the first time in history, we are seeing real-time mobile communication starting to enable the integration of remote workforce to corporate business processes (Rodina et al., 2003). Essentially what we are seeing is the emergence of a truly mobile office (Jutila et al., 2001).

Mobile access to corporate information systems has also a mobilising effect on workforce. With the new technology, business professionals are not anymore so dependent on their offices, facilitating a greater mobility and flexibility. This has been very good news to companies as responsiveness has become mission-critical, calling for increased mobility. (Rodina et al., 2003)

2. Solutions

Mobile business process solutions give mobile employees the possibility to access enterprise applications, such as internal databases and Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Mobile Office Support (MOS) and Knowledge Management (KM). The main functions these solutions offer are:

- Remote access and update of corporate data
- The possibility to transfer field data
- Connecting mobile workers with other sections of the company
- Enabling them to be managed and coordinated from the office

(Derballa & Pousttchi, 2004; Jutila et al., 2001; Rodina et al., 2003; Speier & Venkatesh, 2002)

Rangone & Renga (2006) analysed literature and case studies and proposed two categories for mobile business-to-employee (B2e) applications: 1) Sales-force automation (SFA) and 2) Field-force automation (FFA). An executive brief by IBM (2005) supports this division noting that these two fields are gaining popularity with U.S., European and Japanese companies. In this paper we will follow Rangone's & Renga's (2006) categorisation and add a third category of 'other' to highlight few other implementation of mobile data access.

Sales-force automation (SFA)

The sales-force has always been a very mobile workforce and the first to employ new technologies such as cellular phones in early 90s (Rodina at al., 2003). For the same reason also SFA applications started to develop before any other applications (Rangone & Renga, 2006).

One of the core features of mobile SFA (mSFA) systems is granting access to the corporate data storages. Sales-force can get access for example to customer's details, visiting schedule, sales reports, information on available inventory and status of orders. In addition to access, salespeople are also able to directly update the information. (Rodina et al., 2003)

There is also lots of information that sales-force generates on the field. Very often the salespeople are the primary source of customer information and getting this information for the use of whole company is thus vitally important (Speier & Venkatesh, 2002). Information about customer's needs, sales leads and orders can be uploaded to the corporate information systems in real time (Rodina et al., 2003).

Mobile connection with the company can also facilitate the connection of salespeople with other parts of the company. They can for example gain access to systems and information of marketing, customer service and production. (Rodina et al., 2003)

Finally, mSFA systems also enable better management and coordination of salespeople. Sales-force management can get more recent and up to date information on sales performance and even know the real-time positions of all salesmen. Another example is sales-lead tracking where salesperson gets immediately information about a client from his region who has called the company and asked for additional information. (Rodina et al., 2003)

Field-force automation (FFA)

Field-force is defined as mobile employees (service personnel, repair or installation employees, technical teams, medical workers, etc.) that do not carry out any sales activity (Fitch & Adams, 2006; Rangone & Renga, 2006; Wang et al., 2005). The main difference between field-force and sales-force is that with sales-people it is easier to plan ahead of daily or weekly schedule (Rodina et al., 2003). Field-force representatives often spend all of their days at multiple customer locations. Thus field-force is the group that has the biggest potential benefit from real-time wireless integration with their company and customer. (Rodina et al., 2003)

In general the same features apply to mFFA systems as with mSFA. Access to customer information, whether it is earlier orders or medical history, is still at a premium (Fitch & Adams, 2006; Rangone & Renga, 2006). Field-work has also some specialities. It requires often large numbers of paper work, limiting of which is seen as one of the important functions of real time communication (Rodina et al., 2003). Also the reduced possibility to plan work ahead emphasises the importance of coordination function. Knowing where the closest free taxi, fire truck or service man is, is invaluable information for office and field-force themselves.

Other solutions

There are a number of related fields that fail to fall into the two above mentioned categories. Mobile connection to corporate information system is also used for non-people items. Remote asset monitoring, fleet tracking and light pole monitoring systems that signal office when the bulbs need replacing are just some that are mentioned (Booz, Allen & Hamilton, 2001; IBM, 2005). Logistics is another field where mobile technology is getting more and more emphasis in the form of global order tracking systems (Trappey et al., 2004). Also non-mobile personnel, such as executives, can have need for mobile access to corporate systems while being temporarily out of office.

3. Benefits

Majority of the benefits listed in the literature reviewed lead into one of three results:

1) Worker or process efficiency (Leung & Antypas, 2001; Rangone & Renga, 2006; Rodina et al., 2003; Wang et al. 2005);
2) Process quality (Leung & Antypas, 2001; Rangone & Renga, 2006); and
3) Financial savings.

Mobile systems are more often established in companies with large mobile workforces, but Maguire et al. (2007) have shown that also SMEs can gain competitive advantage through the use of ICT.

The efficiency is mostly a result of increase in job productivity, both on-the-field and in-house (Rangone & Renga, 2006). Studies report that faster access to right information and ability to utilise the "dead time" of mobile workers has lead into clear productivity gains (Jutila et al., 2001; Rodina et al., 2003). Increased effectiveness of sales force due to mSFA is also a factor increasing efficiency (IBM, 2005).

As with efficiency, the quality improvements have effect on both in-house and on-the-field quality (Rangone & Renga, 2006). Eliminating paperwork doesn't only increase efficiency, but also reduces errors. Increased knowledge transfer and smaller error-rate shows to the client as higher quality of service leading lead to increased customer loyalty (Jutila et al., 2001; Rodina et al., 2003).

Finally, mobile business process solutions can also result in cost savings on few fields. Getting the right employee to the right place with right spare part is now easier and also information processing is more efficient leading to reduced costs of administration (Rodina et al., 2003).

Adding mobile functionalities to existing corporate systems may also leverage the earlier investments increasing their ROI (BAH, 2001; IBM, 2005). On the other hand, changing an existing customised solution to meet new integration or process requirements may prove problematic (Arif et al., 2005). In conclusion, the current systems show good results with limited resource investments (Rangone & Renga, 2006), at least for solutions simple from both technical (limited integration to existing information systems) and organizational (few changes in processes) perspective.

An example of a simple mSFA system is one used by Chinese handset manufacturer DBTEL. It used to take weeks to manually collect sales information from over 20 000 locations around the country and the information was often inaccurate and delayed. A SMS based "SMS Maginc" solution was implemented in 2003 and allows almost instant reporting of sales information. (IBM, 2005).

4. Future directions

The current mobile business process solutions are simple (Rangone & Renga, 2006) and task focused (Kar et al., 2006). The field is developing quickly (Rangon & Renga, 2006) and the trend is towards more complex end-to-end solutions (Booz, Allen & Hamilton, 2001). According to a report by IBM (2005) companies are starting to built deeper more tailored 'horizontal' applications in addition to existing simple 'vertical' remote access solutions.

Chan (2000) proposes a three-phase cycle for the role of IT in business processes. According to him IT has the recurring roles of enabler, initiator and facilitator. Enabler is the most traditional role for IT – enabler offers the ability to accomplish something. Initiator establishes a need, in other words a new operation might rise from the use of existing IT. Finally as a facilitator IT serves to make a work or workload easier. For example word processing and printers were of enabling nature leading into networking and multimedia technologies. These developments initiated a change in business processes in for example accounting system. Development of better accounting systems in turn facilitated more efficient operations. This in turn enabled again new operations and the cycle continues. (Chan, 2000)

Drawing on the theory of Chan (2000), it could be predicted that mobile access to corporate information systems will graduate from role of enabler into initiating new functions and calling for business process remodelling. This may also lead to broader shifts in products, business processes and the society as a whole – as has already happened due to ICT's impact on business processes (Chan, 2000). It is very possible that mobile solutions will turn from incremental into radical innovations initiating completely new business models.

According to Maamar (2006) the next trend in mobile systems is to allow users to enact web services on their mobile devices. One can ask if the need for specific mobile business process solutions will disappear if mobile devices are able to access same web-based solutions as laptops and stationary computers. It is however likely that the limitations in screen size and data input devices will continue to require specific mobile solutions also in the near future.

II CASE STUDY

1. Technology

WiseMaster, developed by M-Technology Oy, Oulu, Finland, is an information management solution designed for mobile enterprise use. The WiseMaster product family includes modules for mobile sales force automation (mSFA) and mobile workforce automation (mFFA) (WiseMaster website, 2007).

The typical WiseMaster set up consists of one or more office workstations, one server for managing data transfers and several Pocket PC or Windows CE mobile clients.

A local copy of WiseMaster data is kept at each mobile client, which enables convenient off-line usage. Each mobile client periodically synchronizes with the WiseMaster server. An intelligent synchronization algorithm is used, and only changes are transmitted over the mobile data connection.

Depending on the needs of the end-user and the data connection charging plan, the mobile data connection can be activated manually on demand, or the system can be configured to poll
WiseMaster integrates to other information systems (such as finances) through office workstations. According to Mr Matti Myllylä, CEO of M-Technology Oy, WiseMaster end-users have preferred not to fully automate such integration, but manually approve a set of transactions to be transferred instead (Myllylä, 2007).

The modular structure of WiseMaster software allows custom module development and customer specific configuration of the software, according to Mr Myllylä.

2. Case Company

Our case company, Jasper Oy, has been importing and reselling welding equipment, chemicals and other supplies for industrial maintenance purposes since 1985. Jasper Oy has recently diversified into automotive chemicals and paints. Located in Nokia, Finland, Jasper Oy has an annual turnover of 2,3 M€ (2006) with 46 employees.

Jasper Oy's sales organization is distributed throughout southern and central Finland, with two sales managers at the headquarters and 18 sales representatives on the field.

3. Implementation

According to Mr Heikki Reinikainen of Jasper Oy, it became evident in 2003 that in order to expand the sales organization as planned, the sales process overhead would need to be reduced and the process simplified.

However, because Jasper Oy had no previous experience on using mobile sales force automation applications, they had limited insight into what capabilities and potential benefits an mSFA application such as WiseMaster could offer (Reinikainen, 2007).

Before and during the WiseMaster implementation project this knowledge began to form. The organizational learning process is still ongoing, with new possibilities being continually realized (Reinikainen, 2007). Hence, development and implementation has been gradual, continuous and adjusting.

According to Mr Reinikainen, the WiseMaster solution met surprisingly little resistance from the sales representatives or office personnel. While information entry, transfer and access were computerized, the existing sales and support processes themselves were left more or less intact (Reinikainen, 2007).

4. Application

After an eight-month co-development effort with M-Technology Oy, the WiseMaster mSFA system was taken into use (Myllylä, 2007; Reinikainen, 2007). PDAs with WiseMaster software and mobile data connection were given to the sales representatives, and WiseMaster server and office applications were installed at the office.

Jasper Oy's mobile sales force has access to customer information, order history and product and inventory information through the WiseMaster application. Orders are entered directly into the system. Although WiseMaster doesn't provide a full process view over the order-delivery process, two of the most common process exceptions have been taken into account: information about late payments and deliveries is available in the system.

5. Results

Mr Reinikainen quotes four major advantages delivered by the WiseMaster system. First, the management of sales related information (current and past orders, sales force management reports, inventory) has been streamlined greatly. This has reduced manual labour (human resource cost) both on-the-field and in-house as a lot of paperwork has been eliminated.

Second, information is now entered where it is best available (at the customer site, by the sales representative). This further reduces office workload, delays and errors and thus also improves process quality.

Third, information is available where it is needed in near real-time. This is most significant for sales representatives, who can view customer order history (for more convenient repurchases), and give better estimates of delivery schedule based on inventory information.

Fourth, the psychological effect of utilizing high technology solutions has boosted sales representative morale and customer trust. Mr Reinikainen emphasizes that this effect has been an important factor in the positive sales development in recent years (Reinikainen, 2007).

6. Discussion

The quoted benefits are mostly similar to those identified by Rangone and Renga (2006): productivity and process quality gains both on-the-field and in-house.

However, the sales force morale and customer trust boosting effect has so far received little attention in the literature. These effects may prove independent sources of on-the-field productivity and customer service gains.

The high end-user acceptance of the WiseMaster solution could be explained by the cooperative nature of the implementation project that supported organizational learning (Wenger, 1998).

Following Chan (2000), the WiseMaster application can be seen as having the role of enabler, while business processes and models themselves have still remained the same. However, Mr Reinikainen anticipates that processes could be streamlined further with the integration of navigation and supply chain operations. This could boost the technology into the initiator role and pave the way for a larger scale business process redesign.

III CONCLUSIONS

Mobile business process solutions are used mainly on fields where workers are already mobile. Sales-force automation and field-force automation are the strongest areas where such systems are in use, but also non-manned mobile links to corporate information systems are used. The main benefits of mobile access to corporate information systems are in fields of worker and process efficiency, process quality and cost savings. Additional benefits regarding employee morale and customer trust have been quoted as well.

Today’s applications are still rather simple and task focused process enablers. Development of devices, networks and applications are expected to bring forwards more radical solutions, business process remodelling and even completely new business models.

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