"Preliminary research on existing and planned mobile data service solutions and value systems in leading markets"
Report

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1-Introduction

The purpose of this research is to give an overview about the new services existing and planned in the most important and representative mobile markets. These are supposed to be UK, USA, South Korea and Japan.
This research is based more in done studies than in new additional studies that can be done in these papers. We will try to see where these services are going and what kind of value systems are in each one.
After a quick overview in each of these 11 services more from the point of view of business and players than a mere technical analysis, we are going to go deeply into each service's value system, in order to understand better the value present. When this is already done, a classification of services according also future expectation can be done.
Maybe the aim of this work is to be if there is any "killer application or applications" in this rich and wide area of data 2.5G/3G services.
Services are identified to be the following:

Service Discovery
IP DataCast
Peer-to-Peer
Mobile Email
Mobile VoIP
Push over Cellular (PoC)
Mobile Browsing
Mobile Payment and authentication
Prepaid–anonymous content
Digital Rights Management (DRM)
Machine to machine (M-to-M) and human to machine (H-to-M)

2 **Mobile data introduction: countries' background.**

A new generation is coming to the mobile market, and with it plenty of new data services have already been deployed in this 2.5/3G transition.
New services are coming in different markets in different ways and with different popularity. Looking at different markets we can ask what are the optimal rules for deploying successfully mobile data services and converting a certain market into a leader in mobile data services.
The answer is not so easy as the question, because there are too many factors involved in new services' launching. First of all the cultural background of each country can sometimes explain why a certain service is not deployed in a certain country with high technical infrastructure and on the other hand is deployed in another not so advanced country. Also some services, which are very popular in Japan and in Asia, cannot be deployed in Europe and in America. Also between Europe and America there are a lot of differences. Latin America in its way seems to follow a mixture between Europe and USA, and have presented high levels of growth in mobile markets in some countries.
We can see in figure 1 that the world is already mobile enough to deploy almost everywhere a rich range of data services. In figure 2 we can also see in which countries there are more mobile than fixed connections. It is interesting to see that these countries can be divided into two groups: countries that have been developed for many years as Europe and countries that have developed in last years in a considerable way as Korea and some other emergent countries. Also there are countries with higher mobile penetration because their existing fixed infrastructure wasn't too extended.
It is good to notice that some leading countries as USA have more fixed telephones than mobile connections, despite that they are market leaders. Reasons for this are supposed to be more cultural than technological. Therefore it is needed to go deeper in some background details of each of the leading countries.

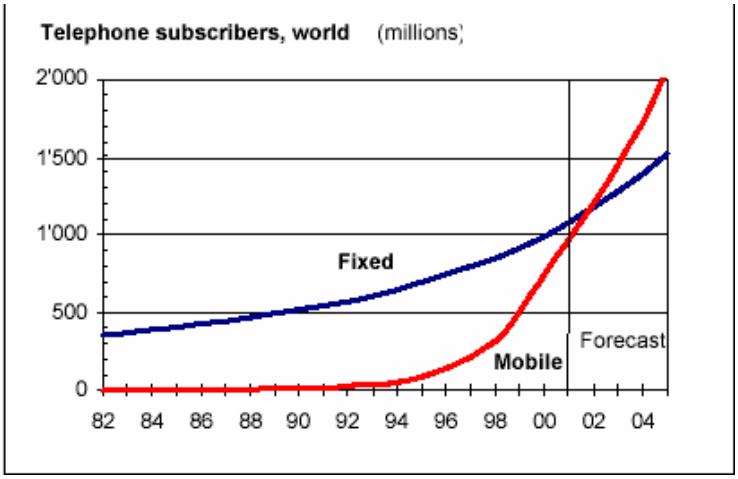


Figure 1: mobile and fixed subscribers worldwide(ITU 2001). [70]

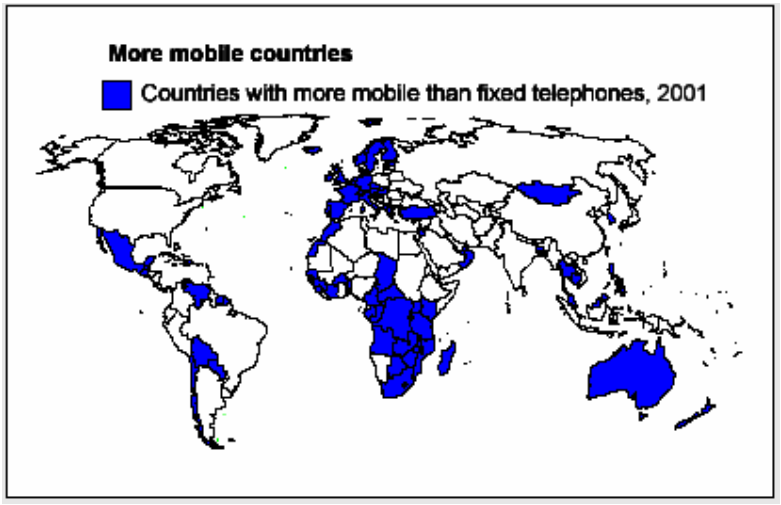


Figure 2 : countries where there are more mobile than fixed telephones, year 2001 [70]

2.1 Japan

Japan is a very developed country in many ways: with a population of 127 millions and a GDP per capita of USD 32 000 is a very powerful and attractive market. Despite of the Asian crisis is a country that is more than alive and was the first country to deploy 3G services. Also the Japanese ICT sector expanded from year 1995 to 2001 from USD 732 billions to USD 1 141 billions (ITU Japan case). Japan has 3 main telecom operators: NNT DoCoMo, J-phone Vodafone and KDDI.
With a mobile penetration of 61% (78 millions), over 64 millions are mobile data subscribers (82% from mobile subscribers).
For 3G penetration KDDI has nearly 11 millions subscribers for its CDMA 2000 1x while DoCoMo FOMA has just over 1.3 millions with its W-CDMA based service. (year 2003) [1]
In Japan the first mobile technology was the analogue "HiCap" system. In 1993 the first digital mobile phone was PDC (Personal Digital Cellular) system by DoCoMo. Also in 1995 was launched PHS (personal handyphone system), with low cost, fast but limited coverage.
The Japan's first 3G (or IMT-2000) technology was W-CDMA in 2001, followed by the deployment of the CDMA2000 1x in 2002 (see details in the table).

		CDMA 2000 1x EV-DO	CDMA2000 1x	W-CDMA
Spectrum occupancy		1.48 MHz	1.48 MHz	5 MHz
Services		Data only	Voice and Data	Voice and Data
Connection mode		Packet only	Circuit and Packet	Circuit and Packet
Maximum data rate per user	**F/L**	2.4 Mbit/s	153.6 kbit/s	384 kbit/s and up to 2 Mbit/s
	R/L	153.6 kbit/s	64 kbit/s (153.6 kbit/s)	64 kbit/s and up to 384 kbit/s
Sector rhroughput (F/L)		Approx. 600 Kbit/s	Approx 220 kbit/s	Approx 1000 kbit/s

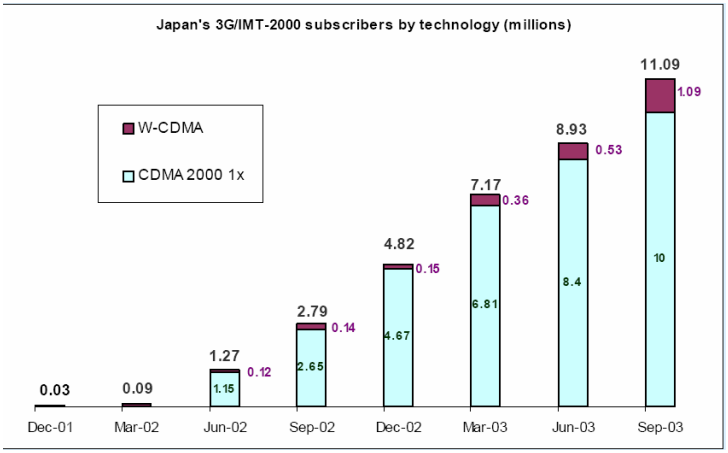


Figure 3: description of technologies and its penetrations in Japan.[2]

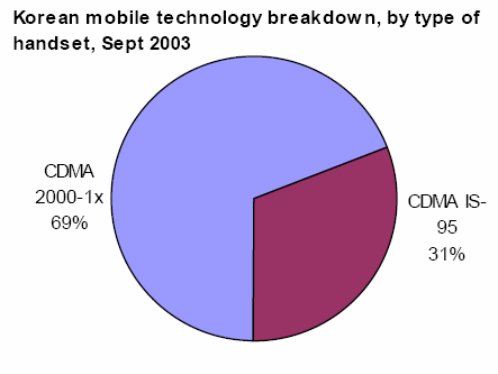
The DoCoMo's i-mode service has been very successful reaching 42 million subscribers.
As in Japan has been forbidden to do voice calls in public transportation, Japanese have increase their data usage when travelling by train, bus, etc. This can also explain some data behaviours.
From the point of view of operators the main difference between Japan and Europe is that Japanese market is operators centred and quite homogeneous, while European market is heterogeneous and manufacturers centred. European operators have focused on protocols, which are usually developed in conjunction with handset and equipment manufacturers. Instead of this, Japanese carriers offer services, supported by their own, operator specific phones. In Europe manufacturer's brand is quite important (Nokia, Motorola, Samsung) but in Japan the operator's brand and the service behind is the most important thing (like i-mode service, for example). [4]
This homogeneity and operators centred features can stimulate both low competitiveness within standards but also quick development in data services.

2.2 South Korea

With a population of 48 millions and a GDP per capita of USD 19 600 (year 2002) Korea is a country that have developed in last years specially due to its competitive ICT sector.
With a mobile penetration of 68.75% (33 millions), it has 22 millions of data subscribers (66% of total mobile subscribers). Its data 3G service is based in CDMA 2000 1x EV-DO technique, which enable lower data speed than W-CDMA but has reached better deployment and penetration speed than this one.
There are three main operators: SK Telecom dominates with a 54% of market share, then follows KTF with 31.4% and LG Telecom with 14.3%. [1]
In Korea during years 84-94 analogue services were offered by state's Korea Telecom with very low penetration. From year 95 digital CDMA was introduces getting high penetration in the market. In 2000 was a transition from CDMA(IS-95A) to CDMA2000 1x, and during the following years CDMA2000 1x EV-DO increased speed. Also WCDMA services are available in some areas.

	Speed	*Adopted in Korea*
CDMA (IS-95)	*13.5 kbit/s*	*Jan 1996*
CDMA2000 1x	*153 kbit/s – 307 kbit/s*	*Oct 2000*
CDMA2000 1x EV-DO (evolution data only)	*700 kbit/s – 2 Mbit/s*	*Jan 2002*
CDMA2000 1x EV-DV (evolution data and voice)	*3.1 Mbit/s*	*Est. 2004*

Figure 4: Technology overview: CDMA development in Korea.
Different penetrations. [3]



Data services in Korea are specially centred in commerce, entertainment and multimedia and location (difference in Japan, where most of i-mode subscribers uses email service).
Also Korea has the highest broadband penetration of the world with 21.9 connections each 100 persons.
The role of the Government is important in Korea. The government has maintained constant relationship with Mobile operators and manufacturers. Mobile operators are in close cooperation with manufacturers, while Government establish price controls and paves the way with necessary regulatory changes.
The Government in Korea has been more than active; much of the Korean success as a mobile information society can be attributed to investment in ICT sector by the Government. Money collected from mobile spectrum allocation were strategically reinvested in ICT promotion rather than in other things as many other countries.
In Korea handsets' subsidy has been a normal way of selling phones in CDMA technology. This has been successful in Korea and out of Korea to promote CDMA technology. Now it is not allowed anymore subsidies in CDMA in order to increase competition, but they are planning to implement again subsidies to promote new technologies (WCDMA). [3]
Also manufacturers as Samsung have gone into the GSM market, achieving a third position in market share after Nokia and Motorola.

2.3 United Kingdom

UK represents in this work also the European mobile markets in many ways, especially if we compare with Japan. In UK the market is protocol centred, and the manufacturers' brand is quite important.

UK has a high degree in competitiveness in mobile market, and is one of the first countries in Europe to deploy innovative services as Vodafone live, which also is starting to use 3G networks.
European wireless technologies with its proposed time path are as follows: NMT (1980, analogue), GSM (1990, digital), GPRS (2000), EDGE (2002), UMTS (W-CDMA technology, 2003). GSM is considered as 2G, GPRS and EDGE as 2.5 G and UMTS as 3G.
In European markets there are two interesting cases: the SMS unexpected success and the WAP unexpected failure; and these have been seen also in England. [4]
With a population of about 60 millions and a GDP per capita of USD 28 000, the UK has many mobile operators. In size order we can mention Vodafone, Orange, T-Mobile, O2, Virgin Mobile and Three ("3"). Can be noticed that in the UK there are much more operators than in Japan with a smaller population. It is possible to say that there is more competition, but as the situation in Europe is not so homogeneous as in Japan, the deployment of 3G services have taken more time.
According Wireless World Forum total revenue for data services will increase in the UK 75% between 2002 and 2004 to € 4 billions. Also the mobile penetration will reach 88.6% in 2004, near the saturation point, but the data services will continue to increase from a 12% of total ARPU in 2002 to 19% in 2004.
In the following table we explain with more details which of the mobile operators are network providers and which of these are virtual operators (MVNO).

	GSM	3G/ UMTS
Network operators	Vodafone O2 T-mobile Orange	Vodafone O2 T-Mobile Orange Hutchison
MVNO	Virgin Mobile One. Tel Mint Telecom 3	

Table: UK's mobile operators. [6]

2.4 United States.

USA can receive the title of most competitive market of the world, and the ICT sector is not an exception. Government's regulations have stimulate from the beginning both local exchange and long distance competition.
USA has a multicultural population of 281.4 millions and a high GDP per capita of USD 34 000.
As USA is a huge country, long distance telephony is quite important. The main carriers with its respective market share are AT&T with 38%, WorldCom subsidiary MCI with 22.4%, Sprint with 9% and others (included regional Bells) 30.7%.
In year 2001 mobile subscription increased to 128.5 millions, representing a penetration rate of 45%.
In the mobile market main service providers are AT&T Wireless, Sprint PCS, Verizon Wireless, VoiceStream, Cingular Wireless and Nextel.

As competitiveness is high, more than 229 millions of the US population lives in areas where there at least 5 competing mobile operators.[8]
Also in mobile standards US approach has been free competition. While Europe adopted GSM and Japan PDC, USA has not adopted any technique, allowing market to decide. From this free market approach has resulted into 4 competing technologies in 2G: GSM, TDMA (time division multiple access), CDMA (code division multiple access) and iDEN. While each technique has its weaknesses and strengths, it is not easy for a company to change from one to another.
As the European model, manufacturers brand is quite important, being main competitors Nokia, Motorola (local) and Samsung.
At the end of year 2001 there were estimated between 8 and 10 millions of mobile Internet users. Anyway still in USA there are more fixed phones than mobile, mainly for cultural reasons. This has also enabled the development of different services as VoIP telephony, which is used at most in the USA.
Anyway the 3G competition has already started and after Verizon's aggressive 3G plans (EV-DO technology) other operators have been forced to adopt 3G services at faster rates; Sprint has announced the deployment of 3G 1x EV-DO wireless data network. Also Cingular has issued a comprehensive request for proposal (RFP) for UMTS infrastructure. [7]
ARPU in mobile services has been quite high in the US. For example, in year 2001 general average ARPU increased 20% to USD 47.37, despite continuing price decreasing.

3 Mobile data services

3.1 Service Discovery

First of all we are going to see a technical overview of Service Discovery mechanisms with its reference in the fixed Internet. When talking about mobile networks there is no any single solution, but main players are already working on it. We will see each mechanism or protocol with its characteristics and challenges. Then we will see general trends.
After the technical overview we will see how in the practice end customers search for services in each lead country.

3.1.1 Technical overview [9]

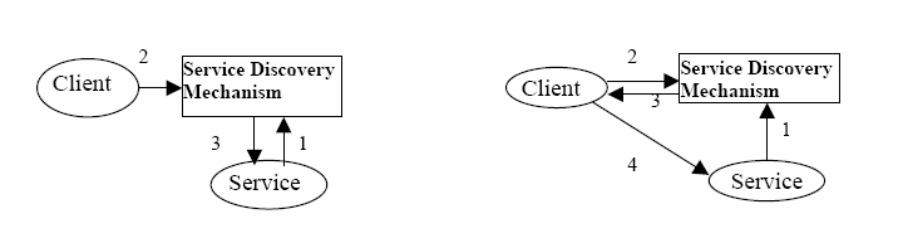


Fig 5: Service Discovery with and without service utilization.[9]

a) SLP (Service Location Protocol)

This protocol is standardized and well documented through IEFT. It has already implementation and commercial products.[71]

SLP is a protocol that is transparent to programming languages. It is concerned only in the discovery of services but not in services' usage (not communication between clients and services; Figure 5). It is flexible and it is scalable to different sizes, and has been implemented already by Sun, Novell, IBM and Apple.

SLP is a decentralized, lightweight, scale and extensible protocol for service discovery within a site. SLP defines service URL which defines service type and address for the service. Support service browsing and string-based query for service attributes. It also uses leasing concept (explained in Jini).

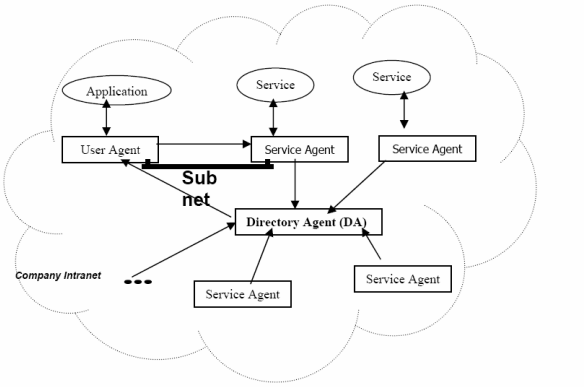


Fig 6: SLP. Without DA works as a P2P system.[9]

b) Jini

It was developed by Sun Microsystems. Is a quite new protocol, and there is no still commercial implementations [71]. Jini distinguished from other because is based on Java. This make that its main developers are important mobile manufacturers as Nokia, Ericsson, Motorola, Siemens and Samsung (Motorola and Samsung are also developing UPnP).

Jini is Java-based meaning that has an independent platform (can rely on mobile nodes). Jini relies on object serialization, code downloading facilities and RMI (remote method invocation).

Jini is concerned both on services' discovery and utilization.
Jini employs concept of leasing; each time a device join the network and its services become available, it register itself for a certain period of time (lease).
It uses multicast in discovery mechanisms meaning that it is not scalable to Internet size networks, but works well in enterprise sized networks (thousands of devices). There is bridging framework between Jin and UPnP.

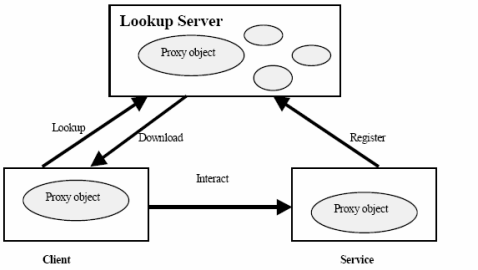


Figure 7: Jini architecture: Lookup Server works as a database for all services.[9]

b) UPnP
Youngest protocol, it is still in early development (no commercial implementations). [71]
Universal Plug and Play by Microsoft aims to advertise, discover and use services in networked devices. It uses protocols as HTTP, TCP/IP and XML, and it is highly dependent on multicast and HTTP. XML is used for service description.
It can act as a P2P or as a directory system. Every device in a network can install a "Control Point" to perform a truly P2P system. For this a device can dynamically join a network, obtain an IP address, convey its capabilities upon request and learn about the presence and capabilities of other devices.
The cost of using UPnP may be high for resource restrained devices or networks. Also its scalability is quite limited: it is for small networks. But it is flexible enough to be bridged with other services' discovery mechanisms.
This protocol has been supported by a large number of companies (Motorola, Samsung, Fujitsu, AT&T, Sony, Intel, Compaq, etc.)

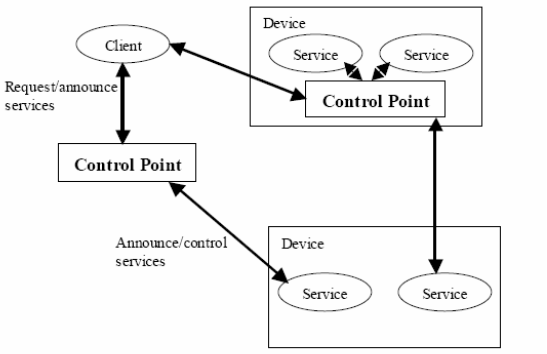


Figure 8: UPnP architecture, client uses RPC (remote procedure calls) using HTTP to invoke services.[9]

d) Salutation
Developed by Salutation Consortium, it was originally thought for printers and similar devices. As SLP and UPnP has both directory style and P2P discovery.

Its architecture is similar to SLP or Jini, but it is independent from programming languages, O.S. and transport protocols.
There are already commercial implementations.

Has the capability to be bridged with any other mechanism and it is also scalable up to enterprise size-network (because it uses SLM discovery and RPC broadcast).

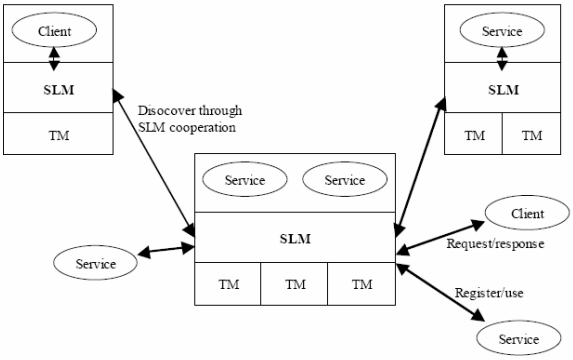


Figure 9: Salutation architecture. SLM: salutation managers, TM: transport managers. [9]

SLM provides transport independent interface to services & clients. SLM discover other SLM in the network through broadcast RPC.
Services are registered in Salutation Manager, and SLM discovers other SLMs and services registered there.

3.1.1.1 General trends

Despite that in the following section we are going to do a deeper comparison, we can talk about some trends in these four main protocols: [9]

- All use multicast.
- All use advertisement or/and service request.
- All depends on TCP/IP.
- There is no internet-size scalability (anyway “enterprise size” is quite big).

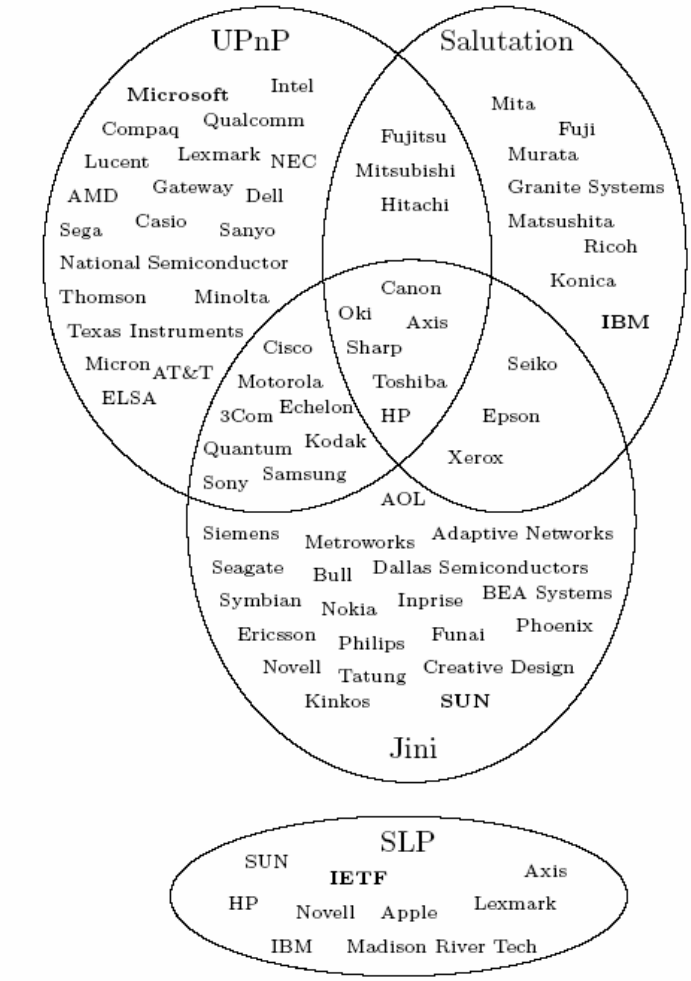
Despite different implementation there are many logical similarities. Also many of them have the capability to be bridged with others. As there is no any internet size solution it is logical to think that different solution must be interoperable between them in order to work.

Until the moment there is no clear choice or trend. Nevertheless there are some effort to join or bridge them: [10]

- bridge Jini-to SLP developed by Sun.
- Salutation architecture is aligned with SLP
- Salutation-Lite (Java version) can emulate functions of Jini
- There is mapping from Salutation and SLP to Bluetooth Discovery mechanism

Feature	SLP	Jini	Salutation	UPnP
Developer	IETF	Sun Microsystems	Salutation Consortium	Microsoft
License	open source	open license, but fee for commercial use	open source	open (only for members)
Version	2	1.0	2.1	0.91
Network transport	TCP/IP	independent	independent	TCP/IP
Programming language	independent	Java	independent	independent
OS and platform	dependent	independent	dependent	dependent
Code mobility	no	yes (Java RMI)	no	no
Srv attributes searchable	yes	yes	yes	no
Central cache repository	yes (optional)	optional using SLP	yes (optional)	no
Operation w/o directory	yes	Lookup Table required	yes	–
Leasing concept	yes	yes	no	yes
Security	IP dependent	Java based	authentication	IP dependent

Table for main 4 protocols' comparison and its main developers.[71]



3.1.1.2 General Deficiencies

In order to adopt large mobile data services as m-commerce, we can think that these mechanisms have still some general deficiencies. [11]

a) lack of rich representation: mechanisms lack expressive languages. For example, protocols don't use any performance parameters, they don't consider if service would be able to serve requester. They are satisfied with finding a service only (SLP).

b) lack of inexact matching: lack power to give a "close match" even if it was available. This is especially with Jini, where services functionalities are processed in the object level (are object interface types), and it is not possible to find the geographically closest service (or printer).

3.1.1.3 General Comparison.

Here we do a general comparison, searching for each protocol its main characteristic or task. Here are the four most important for mobile networks and also some other existing protocols. [12]

Protocol	Main purpose
Bluetooth Disc.	Enables nearby devices to communicate with low cost and low power consumption.
DEAPspace (from IBM)	Ad hoc environment. Algorithm caches service information from each node, and then each node broadcast its knowledge of services in turn.
INS (from MIT)	Service lookup based on P2P technology, more scalable approach to handle millions of services. However, as go through several directories, latency is high.
Jini	Mobile Java codes, which may be moved among clients, services and directories. Platform independency, but clients depend on Java environments.
Salutation	Open protocol and royalty-free. It has two interfaces: one for applications and the other is designed to be independent to transport layer. This means flexibility in transport layer and could be used for more environments.
SSDS (Secure Serv. Disc, by U.C. Berkeley)	Emphasis in security and supports huge number of services (wide area support). Public key and symmetric key encryption used for privacy and security. Message Authentication code for integrity and authentication-authorization available. For wide-area support hierarchical directory structures are considered.
SLP, version 2 (by IETF)	For enterprise environment. SLP only locate a service and leaves the interaction between clients and services. URLs used for service location.
UPnP (Microsoft)	It targets unmanaged networking environments such as home environments. Device oriented Discovery protocol. As all info in XML format (platform and programming language independent) increases interoperability between devices.

	Bluetooth	DEAPspace	INS	Jini	Salutation	SLP	SSDS	UPnP
Service[1]								
Naming and attributes	Standard	N/A	N/A	Standard	Standard	Standard	N/A	Standard
Invocation	N/A	N/A	N/A	Java code	Remote Procedure Call	URL	N/A	XML Data
Status inquiry	N/A	N/A	N/A	Notification and event agent	Notification	N/A	N/A	Polling and notification
Directory								
Centralized vs. distributed	N/A	N/A	Distributed	Distributed	Either	Centralized	Distributed	N/A
Number of Service Information Copies	N/A	N/A	Fully replicated in sub domains, single copy globally	Multiple copies	Multiple copies	Multiple copies	Single copy	N/A
Flat vs. hierarchical	N/A	N/A	Flat and hierarchical [2]	Flat or hierarchical	Flat	N/A	Hierarchical	N/A
Service State in Directories	N/A	N/A	Soft state and hard state [3]	Soft state	Hard state with periodically check	Soft state	Soft state and hard state [3]	N/A
Directory address	N/A	N/A	Configured address	Configured or multicast address	Configured or multicast address	Multicast address	Multicast address	N/A
Number of Directory Hierarchies	N/A	N/A	Multiple hierarchies	Single hierarchy	N/A	N/A	Multiple hierarchies	N/A
Announcement and lookup								
Query vs. announcement	Query	Announcement	Both	Both	Both	Both	Both	Both
Directory-based vs. non-directory-based	Non-directory-based	Non-directory-based	Directory-based	Directory-based	Directory-based	Either	Directory-based	Non-directory-based
Communication	Unicast and broadcast	Broadcast	Unicast, anycast, and multicast	Unicast and multicast	Unicast and broadcast	Multicast	Unicast, multicast, and broadcast	Unicast and multicast
Service Selection								
User vs. Protocol Selection	User selection	User selection	Protocol selection	User selection	User selection	User selection	User selection	User selection
Service Matching	Match all	N/A	Match best	Match all	Match one or match all	Match all	Match all or match best	Match all
Context-aware	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scope-aware	Location /vicinity	N/A	Location and administrative domain	Location and administrative domain	N/A	Administrative domain	Location, administrative domain, and network topology	N/A
QoS-aware	N/A	N/A	Yes	N/A	N/A	N/A	N/A	N/A

Figure 10: comparison between Service Discovery protocols according different technical features.[12]

In Figure 10 we give with more details a comparison between existing protocols. The final solution should be probably a interoperability between most important of these protocols. If we see where main mobile players are, we can see that at least Jini and UPnP can be important protocols in the future. But interoperability with Salutation, SLP and Bluetooth are also necessary.

Now we will present Discovery methods from the point of view of the customer in different lead countries, to see also how these protocols could be deployed.

3.1.2 Japan

In Japan the main Service Discovery service is the portal controlled by operators. [4]
Especially due to i-mode deployment, in an operator based market as Japan, operators have taken the control of the services' portals.
Of course, there are official and independent sites for searching services, but usually official sites belonging from operators are the easiest road to get profits to Content Providers.

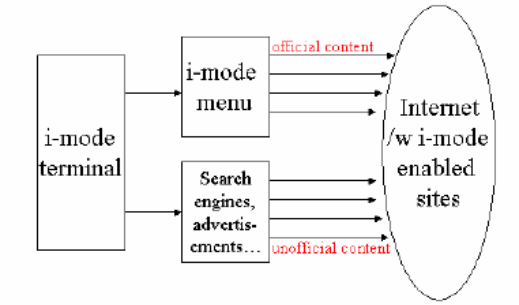


Figure 11: difference between official/unofficial content, and their Service Discovery mechanisms.[13]

Each operator opens up their portals, where it is offered official Content Providers' services. CP ask a fee to operators when they are official (usually the unofficial case has charging system separated from operator's bill via eg. SMS). As being an official CP is the way to the success, it is not so easy to reach this status; operators put their own restrictions and maximum monthly fee (for example USD 3).
Official content is discovered via operator's official i-mode portal. Unofficial content can be discovered via different search engines and advertisements (Figure 11). From the point of the user, portals offer easiness of paying (one bill) and quality assurance of the content.

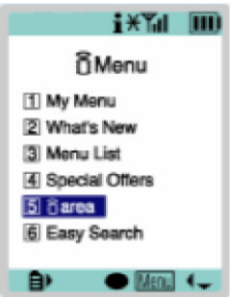


Figure 12: i-area from i-menu offers LBS-type services.[2]

Some examples of popular content in Japan could be location based services through the i-mode portal site or gaming service implemented with a flat rate pricing (eg. Subscription cost of 100-300 yen /month).[2]
With this system of Service Discovery bigger operators have more power and influence to get Content Providers. This is the case of DoCoMo that has about the 60% of the i-mode's market share. Anyway the strategy of DoCoMo has been to charge a low flat rate pricing for content (and press CPs to do the same) while getting revenues from traffic charge (0.0023 €/ packet).
Examples of official content providers are Pokemón, CNN, Dow Jones, Nikkei Net, etc (over 2,990). [13]

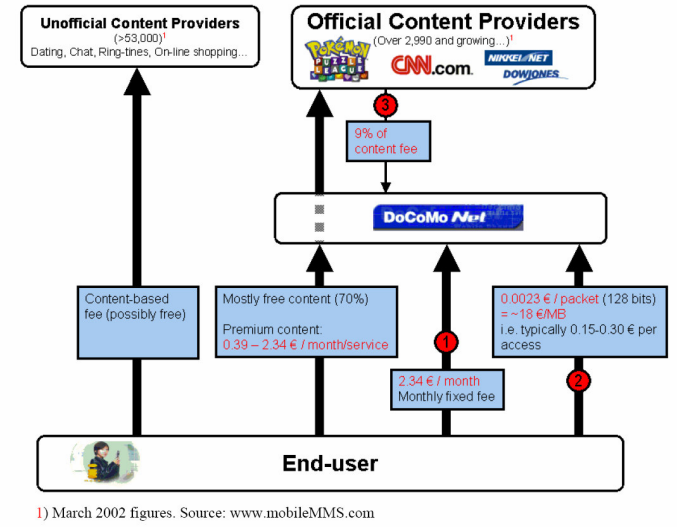


Figure 13: i-mode value system; DoCoMo's case.[14]

3.1.3 Korea

The portal system in Korea has reached also high popularity in the fixed Internet, especially considering the high broadband penetration rate.
A good example of this is Daum Communication Corporation's portal for video on demand (VoD). This portal is the most used in the country for video downloading with 22.1 million users (from only 48 million of population!).
In Daum portal also a flat rate is used (between USD 8.5 and USD12) and can be paid in many ways; SMS m-payment, by credit card or billed to the telephone.

This model in the fixed internet have been seen from 2003 in the mobile environment with the SKT's service "JUNE" EV-DO wireless video on demand. This service was deployed at the beginning with flat rate USD 17/ month and USD 0.85/ film. As this system was highly successful and overbooked, they changed to packet based pricing charging about USD 60/movie. Anyway SKT has not given up the flat rate idea for this service, maybe implementing it with some kind of upper limit.

Figure 14: Daum's VoD portal.[3]

The case of games is different, because each mobile operator has different game platform. Games are distributed through operators games' portal.
SKTruns a Korean game platform "GVM" from SinjiSoft. KTF uses "Brew" from Qualcomm, while LG uses "Java" from Sun Microsystems.

In the game's case the revenue share is at follows: 85% goes to the content provider (eg. Com2Us). Next 5% goes to license the game platform (eg. SinjiSoft) and the finally 10% does to the service provider or operator (eg. SKT) for hosting and promoting the game on its portal. The operator will bill to the customer separately for data charges for downloading.
In the case of music content for ringtones, the company DANAL offers tones for all three mobile operators under different name: Colorring for SKT, Feeling for LGT and Ring 4U for KTF.
In both music and games cases, Service Discovery happens through operator's service portal, and it is not possible to change to other portal than the own's operator. However, in the case of the music, the content provider is the same. [3]

3.1.4 UK

In Europe the idea of portal for content distribution has been the most used until the moment.
In order to compare which are the operators and portal providers in Europe (UK) compared with Japan, we present the following table:

(data from year 2001)	Europe "unique users"	Japan
Portal providers	MSN 20.8 millions Yahoo! 18.2 millions Lycos 17.6 millions Microsoft 16.8 millions	Yahoo! 8.8 millions NIFTY 4.7 millions MSN 4.2 millions NEC 3.5 millions
Network operators	Vodafone 24% Orange 13% T-Mobile 12%	DoCoMo 61% DDI 20% J-Phone 19%
Handset providers	Nokia 49% Siemens 13% Motorola 11.7% Ericsson 10.5%	NEC 28.3% Matsushita 17.9% Sanyo 9.7% Mitsubishi 8.9%

Table: data from 06.2001 (Nielsen Ratings) [4]

Is good to take into consideration that this data is from year 2001, and nowadays mobile operators' portal have increased in market share and importance.
Anyway exist 3 content providing models in portals:

1- portal with direct billing by the operator (operator's mall)
2- portal where customers pay content partners directly (and portal get revenue share for portal usage)
3- advertising or sponsored portals

In UK, WAP have increased in usage last years, with 1 billion WAP pages impressions in 2002, and 8 billions estimated for the year 2003.
WAP, as i-mode in Japan, can enable rich media content. Their implementation has been slower than the i-mode case, but we will see this in Mobile Browsing section. We can put as an example Orange's portal for WAP phones: "Orange World service". Orange offer typical content as ringtones or pictures both by text messages and by WAP.

Other model of offering bigger content to mobile handsets is through fixed internet, as O2 does.
Bilateral agreements between operators and Content providers have been reached certain level of importance, in order to gain the battle of offering better services. As an example of this we can mentions the recent agreement between Vodafone and Sony Music Entertainment, or the partnership between '3' and Sky Sport to offer contents as video clips, video streaming and sport news.[7]

Just to continue with an overview of Europe we can mention the Sonera's "Mobile Fun" service. This is a software that can be pre installed in some handsets (as Nokia 6600), downloaded through portal, downloaded initiated via SMS or web/WAP or separately sold as a card. This program implemented by Sonera act as a content catalogue, enabling to get new content to user's terminals from service providers. From a value system's point of view this program has the same function as a portal. The only difference in this product is that it is possible to see/hear pictures/games/ringtones before the decision of payment. [15]

Figure 15: Sonera's "Mobile Fun" software solution for Service Discovery.[15]

Advantages	Disadvantages
+ **Feature-rich** Can include extra functionality, e.g. a news ticker in addition to article browsing + **User-friendly** o Superior usability, once the application is started o Offline reading function can reduce data traffic and improve user experience o Background download function and pre-defined user interface elements reduce waiting times for download and interaction with the server + **Flexible** o User interface can be adapted to the service's requirements (e.g. content reading, picture viewing) or the service provider's brand o Client software can be updated over the air o While some large operators aim to influence the handset's native UI design, smaller operators lack the necessary scale. UI clients enable this also for lower handset volumes + **Tangible** o Comparable to Java games, consumers more easily associate value to a mobile media service if they see a dedicated programme and icon for the service on their phone	– **Installation/ provisioning** So far, few phones have pre-installed content clients, so that an installation is necessary before content consumption – **Handset requirements** Sufficient memory and a large enough display are needed to deliver a compelling user experience. More advanced clients require an open operating system (Symbian etc.) – **Accessibility** With some terminals starting a Java application requires the additional step of accessing the JAM, choosing the client and starting it

Table: pros and cons of Mobile Fun [15]

3.1.5 USA

WAP portals have also been important in the US market for Service Discovery.
In the US some media companies have used this in order to reach mobile customers directly. This has been implemented as branded content download acting as a marketing tool, and a service billing realised over a premium SMS. Also some operators (eg. Verizon) have chosen to resell content from content providers. The main problem here is not only the revenue sharing but also the brand present in the product; a logical focus of conflict, specially in the case of USA. Despite powerful content providers, operators are willing to establish their WAP portals as the prime sales & consumption channel for digital content. [16]
Also there is a 3rd existing model, where a new player is incorpored into the value system. Retail mobile content business as intermediary between Content providers and customers. As an example nReach Inc offers ringtones, graphics and mobile entertainment that can be purchased with cash or credit card. Content can be delivered directly to mobile phones or via DVD-like packaging. nReach has done an agreement with CinemaElectric, a Hollywood based content provider for mobile devices.
To understand how the retail business in USA work, we have to understand also the peer-to-peer model, quite popular in this country in the fixed Internet, where Discovery happens browsing other user's files through a Service provider.

Anyway Americans are used to buy thing online through fixed internet, and this seems not to change so quickly to the mobile environment. [7]

3.2 IP DataCast

Nowadays this service is more a plan than a reality. Anyway there are already interesting plans in Korea, Japan and UK. USA is late in this service.

In Finland telecom operators and TV operators (TeliaSonera, Radiolinja, MTV, Nelonen and YLE) have joined with Digita to develop the IP Data Cast service, as Digita has planned to use its 4th digi-TV multiplex for mobile datacasting.
In Finland a pilot broadcasting project using DVB-H is scheduled in Helsinki in autumn of 2004. For this purpose they will recruit 500 users in Helsinki's metropolitan area. This project was launched by the Radio and Television non-profit consortium (RTT), and this work was supported by a parallel working group from the Finnish Ministry of Transport and Communications. [17]

A similar pilot project was scheduled in Germany (Berlin) during the spring of 2004. In the case, Nokia, Philips, Universal Studios Net and Vodafone have been the main players in the test of this new service based in DVB-H. The platform combines GPRS and both terrestrial broadcasting DVB-T and DVB-H. Commercial launching is planned for Christmas 2005.[18]

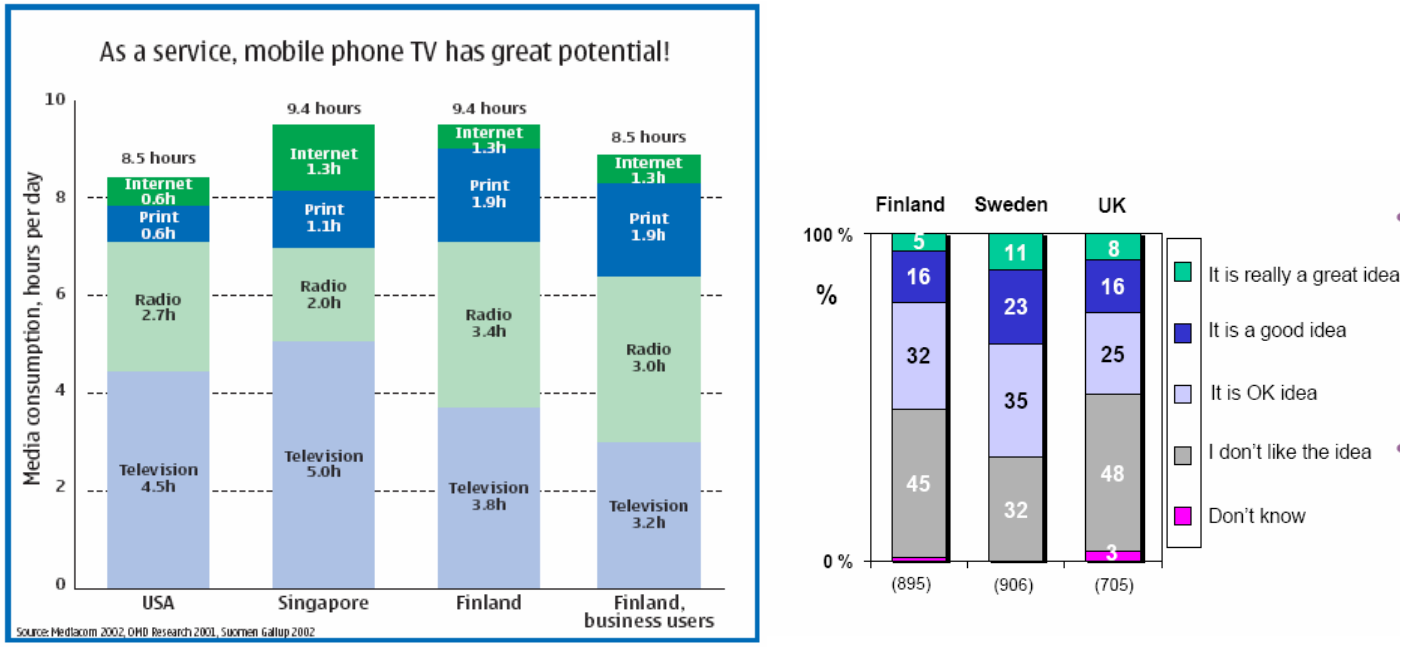


Figure 16: potentiality of IP Data Cast's idea. TV as the most used media in all countries.[19] Right: generally the idea is quite accepted. [21]

Technical overview of the European's DVB-H. [19]

From a general point of view, Digi-TV systems in the world are: ISDB-T in Japan and Korea, ATSC in USA and DVB in Europe. Here we will explain IP Data Cast from DVB's point of view.
IP Data casting use digital TV broadcasting (DVB) for sending digital content. DVB-H (handheld) is compatible with the terrestrial DVB-T and can use part of a reception circuit designed for DVB-T (commercial digi-TV technique for terrestrial transmission operating already in the UK, Germany, Finland and Sweden). IP DataCast is a combination of DVB-H and IP technology.
(Other DVB-techniques are through satellite DVB-S and through cable DVB-C)
IP DataCast is mainly mobile digi-TV, but it has some differences (challenges) with conventional digital TV. Receivers don't have any external antenna, and saving power consumption in the receiver is achieved through 'time slicing' technology (supported by DBV-H). Also DVB-H receives content in high speed bursts.
DVB-H can easily adapt the smaller screen of the handheld; only 128-384 kps per channel is required to deliver a high quality video (this makes possible to send 30-80 TV programs over one network, while in a conventional digi-TV network is only possible to send 3-5 programs).

	Digital TV over DVB-T	IP Datacasting over DVB-H
Display	Large and medium tv screen	Small, mobile phone screen
Antenna	Roof top, desktop or car antenna	Internal
Power Supply	Fixed, continuous	Battery powered, limited
Reception mode	Fixed, indoor portable or automotive	Mobile handheld

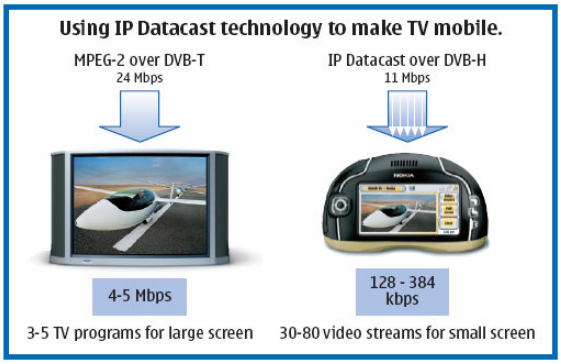


Figure 17: comparison DVB-T vs. DVB-H.[19]

3.2.1 Korea

Korea's plan for a broadband converged network will also include a video component known as Digital Media Broadcasting (DMB), which works as a satellite television for video on demand (VoD). This idea is based on the fact that for VoD services one stream per user is quite inefficient, while when broadcasting digital content on stream is enough for all users.

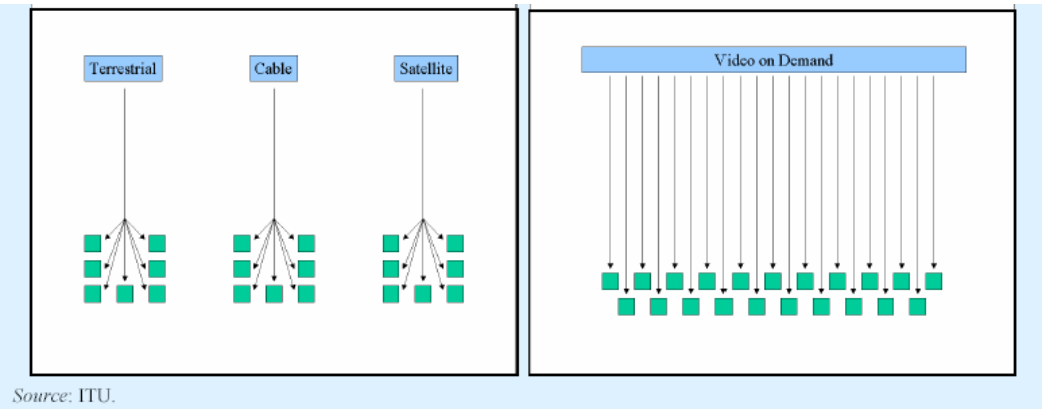


Figure 18: the philosophy of DMB.[3]

Mobile manufacturers in Korea are building already satellite TV receivers into the mobile phones and PDA in a cost effective way to offer this service to customers. As the incremental cost is zero, a flat rate pricing is a logical charging structure. This technique is much cheaper than the existing one. In Figure 5 is possible to see that the old KTF's EV-DO based VoD charges USD 0.03/second, with a total charge of USD 217/month, while with DMB is possible to charge for the same content a flat rate price of USD 15/month.

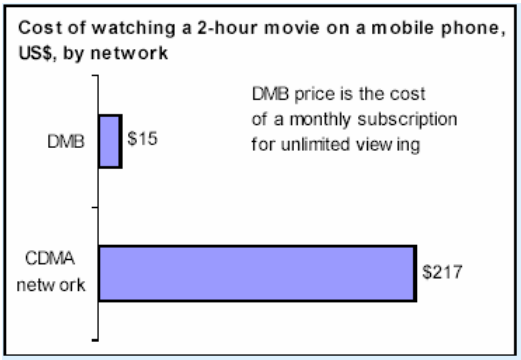


Figure 19: comparison between EV-DO and DMB [3]

DMB is a high opportunity, but it is still needed same technical issues to be solved, as spectrum allocation. Other barriers are unproven user demand and confusing business models.[3]
Anyway SK Telecom and Toshiba-backed MBCO (Mobile Broadcasting Corporation from Japan) are sharing satellite infrastructure's cost for IP Data casting for both mobile TV and radio services.
The launch of the satellite was already on March 2004, but the launch of the service will likely be delayed until 2007 (In Korea and Japan). This MBSAT satellite consists of four high power transponders for direct broadcast services and terrestrial repeater networks covering Japan and Korea. [20]

3.2.2 Japan

Mobile television and radio in mobile phones have some predecessor in Japan. Vodafone released the "V-601N" model with built in analogue TV tuner in 2003.

In the radio area, Sanyo plans to release a new handset for KDDI, the “A5503A”, which has an FM radio tuner built in.
But until now all this services has been analogue, and don’t involve digital broadcasting.

As in Korea, there are already infrastructure and plans for IP Data casting via satellite, but there is no still a clear framework. Operators must get broadcasting licences for offering broadcast facilities.
BB Cable was the first broadcasting station to register into this plan, and is planning to use ADSL network for its broadcast purposes.[2]

Apart from the satellite project leaded by Toshiba’s MBCO, Japan Broadcasting (NHK) and five private sector broadcasters are expected to launch terrestrial digi-TV to mobile phone during year 2005.[20]

Just to mention other initiative in the region, in Singapur Nokia, MediaCorp Technologies, Mobile 1 and local authorities are planning to launch mobile phone TV service using broadcasting DVB-H technique. Also Channel NewsAsia is involved. Nokia had planned to launch the model 7700, the first mobile phone with DVB-H receiver (Nokia streamer). [7]

3.2.3 UK

The project’s name in the UK is DAB or digital multi-media broadcast.
This project has taken the shape of a joint venture in the UK between operators and digital radio companies in order to broadcast digital content to mobile phones and PDA. DAB is operated by BT (British Telecom) Wholesale and GWR (who owns “Digital One” radio).
From a technical point of view it is needed a DAB digital radio chips incorporation into mobile devices. This “one-to-many” digital multi media service want to offer real time services to mobile phones and PDA at similar rates as broadband internet, using Digital One’s digital broadcasting capacity.
This service starting on 2005 is expected to provide revenues for GWR in terms of variable and fixed fees from BT. [7]
Also Nokia is talking in the UK with a number of companies to launch a pilot service bradcasting TV to mobile phones in autumn 2004 using DVB-H standard.
In Finland and in the UK it is needed to pay a TV licence if a user has a TV set, which currently cost €165 /year. One licence covers all television sets in the household. There is a discussion if handheld with IP Datacasting feature would be a TV set or not (users of Nokia 7700 would need to have a licence, for example). Anyway with one way or another, flat pricing is the most probable pricing of this service.[20]
Also in Europe is good to mention the company DiBcom, headquartered in France, which has been positioned as the leader in digital television reception circuits for mobile phones for DVB-T and DVB-H techniques. This company has Fujitsu Microelectronics Europe as partner, and has successfully raising fund of € 10.7 millions (from Motorola and others).[21]
This company is offering DiBcast service (software that displays TV on PC) in the UK including the Digital Teletext feature. [22]

3.2.4 US

In the US it is seemed that the IP Data Cast development is quite late compared with other countries (five years away, according Wireless Web News's article [20]). Anyway Sprint has offered, with its PCS Vision Phone, world's first live streaming TV content service. This subscription service developed and operated by Idetic offers the most popular TV channels as MSNBC, CNBC and Discovery Channel. This is not a broadcast technique.

General Conclusion

The main idea of this service is that IP Datacast involves new players into the mobile data services, specially TV channels and radio channels. In Korea, IP Data casting can be used for Video on demand services also.
Anyway broadcasting channels acts as a content providers with the same model as any other content: agreement of cooperation and revenue sharing with usage or flat rate pricing. Especially in the case of Korea is quite clear the idea of a flat rate pricing in this service. But there are also plans for charging two times separately for the content and for the mobile service.
Generally different services that can be deployed with this technique are:
-broadcast enabled mobile phones
-laptops /web pads in cars
-portable TV for inside and outside home.

3.2.5 Value systems.

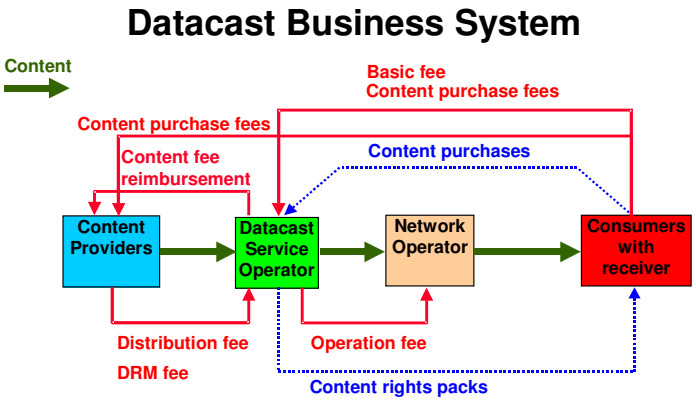


Figure 20: source IPDC Forum [21]

As this is a planned service there are still many possible business systems to be deployed.
The most general and simple value system is from IPDC forum, where the fee (probably flat rate) is given to the data-cast service provider.
Content provider receives a fee from content's rights and Network operator get benefits from the traffic.

The other possibility is to separate broadcast and mobile services. Also, it is possible to distinguish a 'Content Aggregator'.
Main players are identified to be:

a) **Content provisioning**: this service represent new business opportunities for content providers, as mobile TV offers a new distribution channel
b) **Content aggregator**: this role is similar to today's TV broadcasters; they purchase content from content providers.
c) **Data-cast service provisioning**: company which operates data cast service and controls capacity available on digital broadcast networks.
d) **Data-cast network operation**: operator of the IP Data-cast network which owns and operates infrastructure (transmitters, mast sites and connections to the site).
e) **Cellular network operation**: as the broadcast network operator, operator of the cellular network owns and operates cellular infrastructure.
f) **Provisioning of cellular and e-commerce services**: cellular service provider can offer beyond connection consumer authentication, cost-efficient billing services and customer relationship. Also the provision of e- or m-commerce enables the user to buy subscriptions for mobile TV content.
g) **Handset manufacturers**: good quality TV is still missing from manufacturers, it is needed to improve memory and processor capacity.
h) **Service and network infrastructure vendors**: new servers and application will be required by IP Data cast service operators and e-commerce service providers.
i) Users

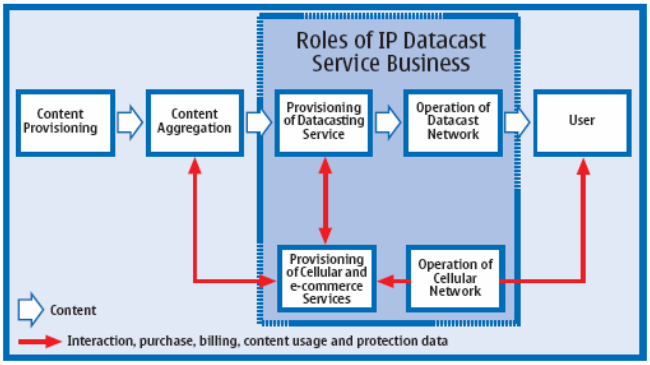


Figure 21: from Nokia's white paper [19]

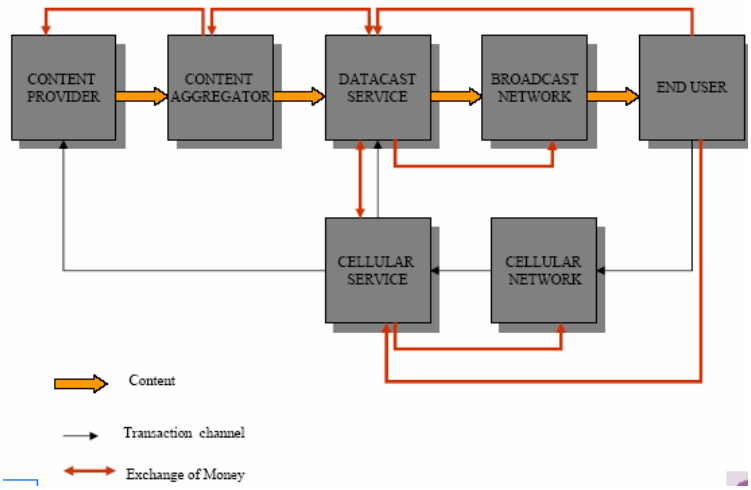


Figure 22: from Teracom, IPDataCast [21]

In this last model it is needed to pay two times for the same service to Data cast service provider and to mobile service provider. From the user's point of view is much better to pay once. In the case of Korea this service will be probably implemented with a flat rate pricing. In the European model, where usually there are more players could be possibly implemented both models depending on the country.
I dare to say that pricing in this service will be critical; all depends on agreements between different players.

3.2.6 Regulations

As this service involved many new players it is needed new regulation for its successful deployment.
In Asia, the Korea's government involvement and synchronization with telecom players is in contrast with the miss of clear rules in Japan.

In Europe IP Datacast is in the agenda of the CEPT (European Conference of Postal and Telecommunications Administrations) for broadcast spectrum re-planning process. It is needed a sufficient and appropriate spectrum capacity for these new IP Data cast services. The main object of standardization of IP Data cast is to create basis for global and horizontally structured market.[19]

3.3 Mobile Peer-to–peer (P2P)

3.3.1 Definition

"Peer-to-peer, or abbreviated P2P, refers to a logical structure of network where the communication is done more from one node to another instead of many nodes depending on a central point in the network" (from Kephyr 2003/2004).
According this definition Internet could be an example of P2P network, but nowadays is referred more to exchange of content (music, etc) in a direct way. From a general point of view it is possible to exchange files directly with each other directly or through a mediating server. So we can divide pure P2P and mediated P2P. Also in the mobile atmosphere messaging as SMS or MMS are considered as person-to person messages, but technically are not considered as P2P, because they go through a server. But from the economic point of view MMS share features with P2P business system (DRM, etc).

3.3.2 Fixed P2P

P2P technologies are a reality in the fixed Internet. Especially in the US this technologies are widely used, despite that sometimes have been outside of a legal framework. The future of this service is somehow related with a DRM, service that we will see separately. But to understand this technique we are going to check existing business models, especially in the USA fixed case and then a future perspective of the mobile case and the possible pricing model for P2P services. As mobile P2P want to succeed have to compete at least with same advantages for customers than fixed models.

Before seeing models we are going to talk about general features of P2P market in the USA. It is estimated that all P2P services have 57 millions users, and the most popular system's software (Kazaa) has been download 230 millions times worldwide. As an example of a measure, a typical Wednesday afternoon (peak moment), will have typically 4.2 million users sharing files and 900 million files being shared. [72]
In 2002 it is estimated that the population of Internet music downloaders have reached 30% of the US population.
Also Forrester research (March 2001) says that in the USA 70% of online music consumer are willing to pay USD 9/month for digital music subscription, and 45% are willing to pay USD 20. So, in the US market there are already existing habits of P2P charging in a flat rate way.
The P2P model has started in the US Internet, and has spread worldwide. Fixed P2P doesn't depend on different countries, so we are going to study existing fixed P2P worldwide model, with an especial accentuation in the US market.[23]

a) KaZaA
   Is a popular "P2P client" with 1-1.5 million users in 2002. This system doesn't use any kind of DRM or payment systems that can benefit content authors. There are some legal fights against this service, and probably it will change.

b) Napster
Based on monthly basis users paying USD 5-10 to download up to 50 files (songs). Napster has created new file format NAP enabling simple DRM system. This means that artists can set own rules about how music files are used.

More about Napster case [24]

According a study in January 2001, 68% of the 40 millions users of Napster were willing to pay USD 15/month and 81% will pay only USD 5. With this information, the new CEO adopted a new strategy, where a basic service will be offered for USD 3-5 and an unlimited service for USD 6- 10.

Napster offered to five main record companies no less than USD 150 million per year for music agreements, and USD 50 million to independent companies. This offer was rejected by music companies. From year 2003 Napster is offering two services: a flat rate service of USD 10/month and a usage based tariff of USD 0.95 per track.

c) Lightshare
This service have implemented some centralization methods in order to monitors file's progress to ensure that content doesn't change. This is not pure P2P, but comes from the idea that it is inevitable to enable some degree of "mediated" P2P in order to implement DRM .

d) CenterSpan Communications
This company's solution aims to create a secure channel for content distribution using P2P-like methods. Here users can't publish any content and don't have any control, and try to deploy a "mediated P2P".

The issue concerning copyright liability of a P2P service is important, and there are controversial opposing judgments against KaZaA and Napster.

From a technical point of view P2P technologies will have inherent problems in wireless environment for high price cellular systems. But as professor Kantola says, "it is possible to develop protocols, which can compete also in wireless systems to lower data tariffs to a similar level per transmitted bit as the current voice tariffs". It is clear that mobile P2P need at least the offer the same or better value preposition than the existing fixed model.[26]

A study in the US shows that the reasons for using P2P are the followings:

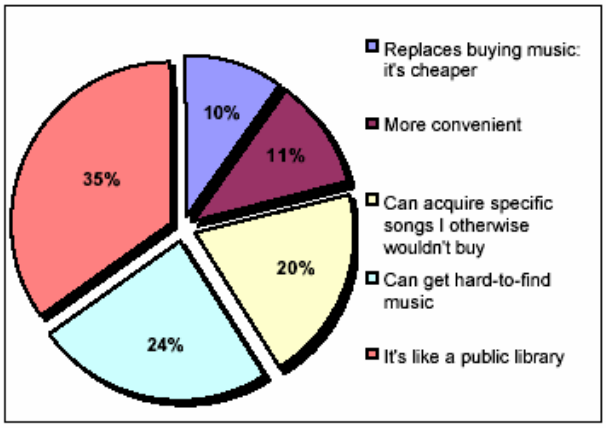


Figure 23: Reasons for using Napster [25]

It is quite symbolic this research, because shows that P2P increase the usage of music rather than replace the old CD system (only 10% replace one system for the other). People use P2P for convenience or easiness to find rather than because it is cheaper. We can think now in the mobile case, were could be possible to charge if it is offered an even easier way of getting music (or content) than in the fixed case. In the theory could be possible to charge even more than in the fixed system, if in the mobile model content is more "available" to offer a better value than in the fixed model.
Also we can suppose that in the mobile model is not possible to charge in a radically different way than in the fixed model.

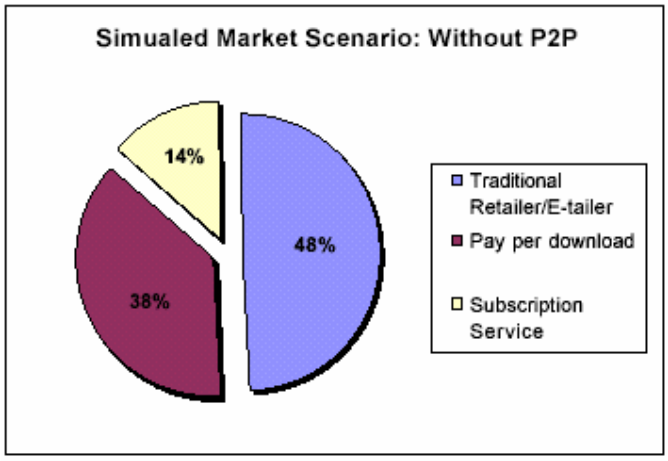


Figure 24: potential downloaders' preferences.[24]

In Figure 7 it is possible to see how only a 14% of downloaders would like to a subscription based (flat rate) compared with a 48% willing to pay for each download. In this simulation is not considered the free P2P possibility, in order to compare better usage v/s flat rate pricing. It is very interesting to realize that for the music case not always flat rate pricing is the most popular, as someone could think.
The most logical solution when pricing mobile P2P is deploying both flat rate pricing and per download pricing, depending also on the content type.
In the case of the music P2P open lots of possibilities and new business models. For example open up more possibilities of bundling different products. Also in P2P could be possible to listen to the music before downloading it.
From the point of view of the customers, P2P enables better and easier market segmentation, compared with the traditional music retailing market. For this purpose a good customer relationship management is needed (CRM).
Also with the deployment of a DRM for super distribution could be possible to price for item, for subscription or even as "per -run" pricing.

3.3.3 Mobile P2P's double charging

Due to the widespread SMS usage and a solid billing platform, consumer in Europe in the year 2006 will spend twice for mobile content than for PC's content (and they were already doing so in year 2002). This comes from the fact that consumer is used to pay for premium content in the mobile atmosphere, if the content is anytime, anywhere. Mobility is a value in itself.

DoCoMo's approach seems to work well: charge for traffic, and low flat rate for content. This can also be deployed in P2P mobile system.
In the section about DRM we have explained also how MMS can be a driver to super distribution at the beginning. But MMS is always reduced into a certain size.
It is good to take into consideration that in the fixed model people use P2P for convenience and easiness rather than for the price. People are ready to pay more if it is easier to get some content. Anyway for super distribution of content with a certain size it is logical to think that if charge system doesn't change, people will send things locally. This means that super distribution of big content it is not going to be so wide, and it is reduced to a circle of known people.
Nobody could get a film via mobile P2P nowadays. But smaller contents' distribution could reach popularity through P2P systems. Anyway if double charging still remains in the future, mobile P2P will never be as big as fixed P2P.[27]

3.3.4 Mobile P2P solutions and usage

Technically mobile resources are not as big as fixed resources nowadays. For this reason, main obstacles when using mobile P2P could be:
-connection cost
-network efficiency
-long download time.
These factors are related, because when network efficiency is not good, download time is longer, and cost is higher. In this environment an efficient resource usage is important.
There are some technical solutions as Gnutella, which could use better resources in mobile environment. Gnutella is a quite dynamic protocol and in mobile environment users are likely to start and stop application more frequently. Also in Gnutella the load to network resources depends on the network topology.
According some measurement 'Semi-Random Mesh' and 'Connected Stars' topologies are the ones which use at best network resources with Gnutella protocol (this can be reached with fixed servers in a start shape, for example), and this is good to take into consideration when deploying this service.
Despite the technical matters, we can say that the price model will affect the way how mobile P2P will be used.
While in the fixed internet music sharing has been the driver for P2P services, we can think about what kind of services people would exchange in the mobile P2P. As mobile P2P is cheaper in a local way, probably the most exchange content between smaller subgroups within a geographical proximity. This mean that content could be more group-specific content as user-created or location based content, for example. [73]
Anyway, if we want to extend more the usage of the mobile P2P it is needed at least to compensate consumers with a reduce service cost when sharing files.

3.4 Mobile Email

The email has been identified as a killer application in the fixed Internet. In the mobile case this doesn't seem to be so clear always. Despite that this is a service working already many years, its deployment has not been so quickly in Europe. In Asia, especially in Japan, things seem to be different.
From a general point of view mobile Email can work in 3 ways: browsing (WAP, i-mode), ready email solution with SMTP/POP/IMAP protocols, and Blackberry (as a separate solution).
POP solution refers to a mail solution, where mails are received from internet and held for customers by Internet Service Provider (ISP).
IMAP (Internet Message Access protocol) is a more sophisticated method than POP and allows checking the email from any device.

Laptop	PDA	Advanced mobile phone (Nokia's series 60)	Basic mobile phone (Nokia's series 40)
HTML SMTP/POP/IMAP	WAP 2.0 (XHTML) HTML Blackberry SMTP/POP/IMAP	WAP 2.0 (XHTML) HTML SMTP/POP/IMAP	WAP 1.2 (XHTML/WML)

Different solutions are offered both to consumers and corporate customers. Especially interesting is the small/medium sized business consumers. In Figure 25 we have some "inexact" projections about ARPU according Critical Path's solutions, which give segments' order.

Figure 25: stimulate business growth across multiple markets. [28]

Just as a point of reference we can give mobile internet penetration in different countries, as browsing is one of the possible ways of using mobile Email.

Japan	79.2 %
Korea	74.9 %
USA	8.9 %
Finland	29.1 %

In Europe it is estimated in year 2002 to be 34 million WAP connections from a population of 400 million users (less than 10 %).

3.4.1 Japan

Japan is the country, where mobile internet is used at most. Mobile Internet has been introduced in Japan especially through i-mode service.
In ITU study from year 2004 can get main reasons for using mobile internet:[2]

E-mail	83.3 %
Music	45.8 %
paid content	37.3 %

In Japan it is possible to conclude that Mobile Email has been the main driver for i-mode's success. We can add to this that when i-mode was introduced, the fixed Internet penetration was lower compared to other markets, and there was not existing services as SMS, popular in Europe. In other words, the need for a cheap messaging service has enabled the success of the Mobile internet.[5]

3.4.2 Korea

In Korea mobile internet has been popular, but for other purposes than Mobile Email.

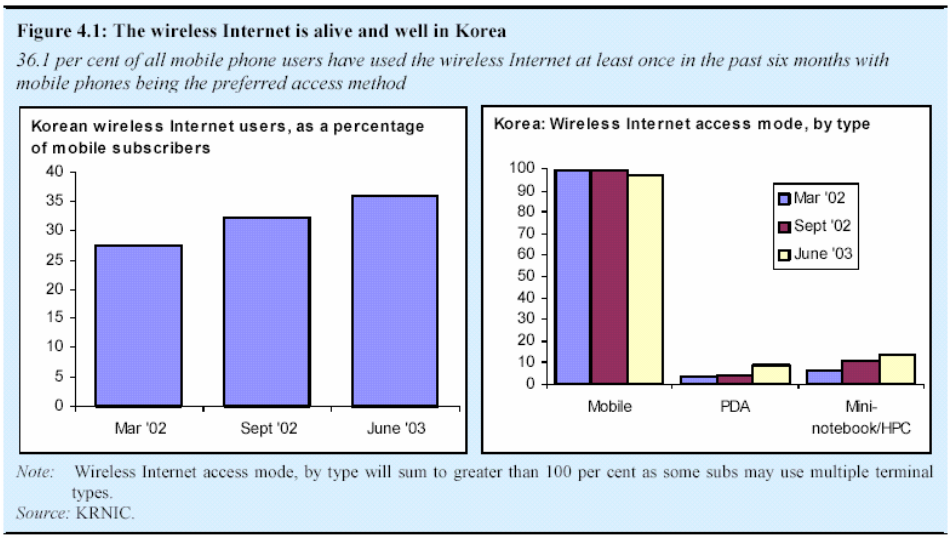


Figure 26: mobile internet in Korea [3]

While mobile Internet users are increasing all the time, but more for searching information or downloading game than for mobile Email. In Korea only 5.2% uses Mobile Internet for Email service.

3.4.3 Europe and UK

In Europe Mobile Email has grown but not as the same rate as in Japan.

In the following table it is estimated how this service will grow in terms inactive users.

Europe (% from total)	2002	2003E	2004E	2005E	2006E	2007E
consumer e-mail	0	2	6	11	16	22
corporate e-mail	0	1	3	7	9	10

[5]

The dimension in penetration seems to be much lower and taking much more time than the originally thought. There are two main reasons for this: the unsuccessful launch of WAP services in Europe and the successful deployment of SMS messaging. SMS is at the same time simple and successful and have been deployed throughout Europe. While mobile phones are seemed to be done for SMS are not well designed for e-mail. Only in business Mobile email seems to have a more critical value.
A Nokia's research done on September 2003 tells that 39% of the companies are willing to provide Mobile Email services to their workers.
According Global Wireless Projections (2003) in Europe, mobile revenues are expected to increase from USD 49 millions in 2003 to USD 2.9 billion in 2008. Also in 2008 40% of people with business mobile phone is expected to use mobile Email. (year 2003 less than 1%)
We can say that mobile Email in Europe has at least high expectations in the future.

3.4.4 USA

In the USA (and also in other European countries as UK) the Blackberry solution has been popular. Blackberry mobile Email was introduced in 1999 and has spread especially within small/medium business and enterprise/government organizations. Here we explain first how Blackberry works. [29]

1- Email is sent
2- Email arrives at “Blackberry server” and sent as normal to user’s desktop or PC.
3- Server compresses, encrypts and forward message automatically to user’s handheld.
4- Email is forwarded to handheld, via Internet and wireless network
5- Handheld receives, decrypts and decompresses the email.

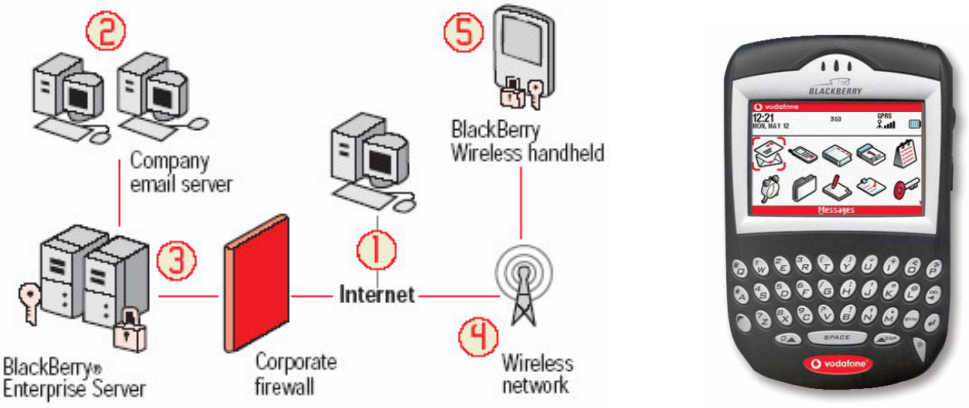


Figure 27: Blackberry solution, from Vodafone. Right: Blackberry handheld
Blackberry represents a whole solution for enterprises, and need also specialised servers in order to deploy it.

Despite the uncertainty surrounding its case with NTP, a litigation problem for Blackberry's patents in the USA, with a potential to hurt the company badly, RIM (Research in Motion) posted its fourth profitable quarter in row (June 2004). For the quarter ended May 29th RIM got USD 269.6 millions. RIM's revenues comes from 68% handhelds, 19% IT services, 9% software licenses and 4% others.
RIM claims to have now 1.34 million total Blackberry subscribers.
This is a quite good success; according market-research firm Gartner, "sales of Blackberries more than triples during the first quarter of this year." (2004) [31]

Other solutions:
As an example we can talk about Nextel, which offer mobile Email solution through SMTP/POP/IMAP. Nextel's Mobile Email offers wireless to existing corporate Microsoft Outlook and Lotus Notes email accounts as well as most POP3 accessible accounts (provided by ISP). Nextel uses "Nextel Desktop Assistant" software in order to deploy this service. This software can be downloaded.
Prices are deployed both as per message basis and flat rate pricing. In the "pay –as you-go" it is charged USD 0.1 to send a message and USD 0.1-0.15 to receive.
In flat rate pricing it is charged USD 5 /month for mobile Email solution and USD 15 for the full package included web browsing.
This solution doesn't work with Blackberry handhelds. [30]

3.4.5 Mobile messaging comparison

To have a wider overview we are going to compare different types of messaging. First of all, we will compare Mobile Email and SMS in different countries (operators) in terms of ARPU. It is possible to see that in Japan Mobile Email is very profitable, as much as SMS in Europe. In the USA messaging in general is not a profitable service.

type of message	**Service provider**	**ARPU in USD**
Mobile Email	J-Phone (Japan)	58
	Sprint (USA)	5
SMS	Vodafone (UK)	59
	Verizon (US)	3
	O2 (Germany)	55

[32]

In the followings tables we will compare estimations of messaging in Europe. To understand how new services can replace old ones.
Short MMS (only text) and picture messaging (or long MMS) is considered separately, because MMS has a potentiality to cannibalise SMS, and in this way it is easier to understand this process. Also video messaging is believed to use MMS for short video clips.
IM (instant messaging) has big potentiality, but remains with small market size. It is considered that it is needed to offer Java enabled handsets, which enable to be updated when necessary. Some IM solutions are for example: AOL, ICQ, MSN and Yahoo!.

(active users from total subscribers)[5]

Type of message	2002	2004 E	2006 E
SMS	57%	65%	70%
Short MMS	0 %	4%	29%
Picture messaging	0 %	15%	29%
Instant messaging	0 %	4%	7%
Consumer email	0 %	6%	16%
Corporate email	0 %	3%	9%
Video messaging	0 %	2%	8%

Availability of services by handsets, estimations.[5]

Service (technical requirement)	2004 E	2006 E
SMS (SMS feature)	100%	100%
Short MMS (MMS feature)	39%	73%
Picture messaging (camera)	25%	45%
IM (Java)	41%	74%
Consumer email (GPRS/3G)	56%	82%
Corporate email (wireless PDA)	5%	14%
Video messaging (camera)	25%	45%

(ARPU in Europe per messages, € per month per sub) [5]

Type of message	2002	2004 E	2006 E
SMS	**4.04**	**4.35**	**3.83**
Short MMS	0.0	0.04	0.36
Picture messaging	**0.01**	**0.56**	**0.83**
Instant messaging	0.0	0.09	0.2
Consumer email	0.0	0.04	**0.28**
Corporate email	0.0	0.16	**0.44**
Video messaging	0.0	0.02	0.08
Total	**4.46**	**5.26**	**6.02**

This tables shows that cannibalization happens against SMS, but anyway general ARPU increase with the deployment of new messaging services. Anyway in the near future no service is supposed to reach SMS's levels in terms of ARPU and penetration. For example, consumer email will reach only a 16% in the year 2006. And in terms of ARPU mobile email's estimation is much lower than MMS. Anyway is good to notice that corporate users have less penetration but higher ARPU.

Pricing

Until know the pricing in Mobile Email have been implemented with GPRS based model according the data size. We can think that Mobile Email is a substitute of the MMS more then of the SMS. Comparing different tariffs typically mobile Email is cheaper than MMS, while MMS is better for time-critical messages.
Generally MMS pricing have been per message (until certain size) rather than per size (also in Finland). In the UK, T-Mobile has deployed MMS with flat rate pricing to incentive its usage.
Also Blackberry has been deployed with flat rate pricing. (Ex: US's Earthlink tariff USD 39.95/month)

3.4.6 Spams in Mobile Email

Spams in the I-mode are even higher than in the fixed Internet. Anyway in both there is a problem that can have also economical implications.

To fight against this, NTT DoCoMo changed users' name (from phone-number to number-letter arrays so that is more difficult to guess users' names).
To explain the magnitude of this problem we will give an example about i-mode. In October 2001 DoCoMo delivered 150 million messages/day and 800 million messages bounced for non-existing user (probably spams). This is a huge economical burden in Mobile Internet, especially if we take into consideration those users who pay for received e-mails. In the last time different operators have introduces services where there is no need for pay when receiving spams. DoCoMo implements this, allowing users to get refunds for received spams.
Some people think that the biggest challenge in this area is to achieve combat against spams without sacrificing the ease of use of the Email. [34]

3.5 Mobile VoIP

VoIP technology has existed already for many years. The IP telephony have been deployed successfully already in the USA, and in some other countries. In Europe for many reasons the VoIP's deployment have not been so quickly. Some people think that mobile VoIP is coming through Wi-Fi technology and there are already some implementations. In this section we are going to evaluate in each country which are the possible steps into this new service.
First of all we are going to see how is broadband and Wi-Fi penetration in lead countries, requirement for VoIP and mobile VoIP.

From ITU, broadband penetration (% of household)

Korea	94 %
USA	18 %
Japan	27 %

Wi-Fi connections, measured and estimated.[34]

	2001	2002	2003	2004	2005	2006
Europe	50	1,000	5,000	9,400	17,700	24,000
Americas	750	4,000	18,000	30,000	45,000	55,000
Asia	100	10,500	25,000	51,500	69,000	83,000

3.5.1 Technical issues in fixed and wireless VoIP.

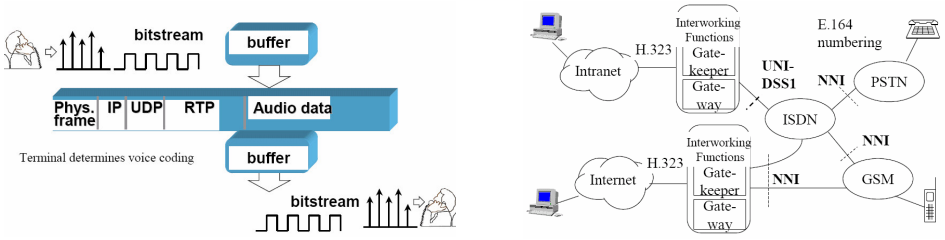


Figure 28: fixed VoIP main technical features.[36]

We can see briefly in the picture above how IP telephony works. It is needed in the terminal a coder-decoder, which must convert analog calls before they can be transported over a packet-switched network. Also it is needed gateways if we want that IP network can communicate to other networks as GSM or PSTN. It is good to notice that this is not an expensive service to deploy.

Despite that fixed VoIP is already working in many places, it has some technical problems, due to the IP network nature. They are mainly 3:
a) **delay**: algorithmic delay, processing delay, network delay and delay stemming from hardware interfaces. Also because of the nature of IP network, the delay is different in different paths.
b) **jitter** (distortion) complicates the decoding in receiver device. For this purpose it is used jitter buffer to have packets available when needed.
c) **packet loss**: if there is a long jitter buffer, packet loss can be removed, but at the price of increased system delay.
[35]
In the wireless environment there are existing solutions of mobile VoIP through 802.11 WLAN environment. In this medium the problems mentioned above are further accentuated because of its lossy nature.
When several users are connected to the same access point, congestion easily occurs. A common delay in WLAN environment could be 500 ms (too much for voice). However many solutions are now available to cut delay to 20 or 50 ms.

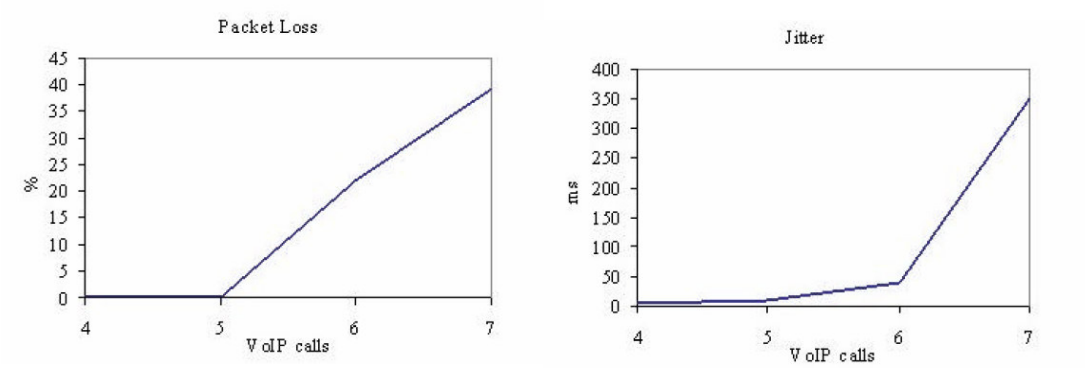


Figure 29: in this informal test we can see that nowadays from 5 users IP telephony over Wi-Fi doesn't work anymore. [35]

WLAN also usually operate in the unlicensed 2.4 GHz frequency range and share the same spectrum with other wireless technologies (Bluetooth, cordless phones, etc), causing interference. Poor link quality leads to increased number of retransmissions, which affect also the delay and jitter.

Solutions [35]
-Need of high quality, high bit rate and low complexity codec.
-New algorithm (recently introduced) which combines an advanced adaptive jitter buffer control with error concealment which can save one-way delay of 30 to 80 ms.

-deploy sophisticated algorithm or speech coding technique to handle more efficiently packet loss.
-implementing QoS, with a prioritization of voice and video packets. The deployment of WLAN QoS standards has been slow, and it is estimated to take a long time.

To understand how regulation could also affect to this new service, we describe briefly in the following table how the situation of IP telephony in each country is.

Regulations in each country about IP telephony [37]

Country	Treatment of internet telephony
UK	It is likely that Internet telephony would be treated as a form of resale.
USA	Not subject to regulations.
Korea	Service providers would be classified as special service providers and would need to register. Regulations such as “Telecom. Business Act” would be applied to them.
Japan	The law doesn’t prohibit the offering of voice services over Internet.

3.5.2 USA

The fixed VoIP telephony has been deployed in the US quickly and somehow successfully. There are many reasons to explain why this has happened here and not in other places.
Traditionally in the US, as the main trend in telephony has been competency, local telephony have been very cheap, with flat rate pricing or even for free in some places, while revenues have come to operators through long distances services.
We can add also that in the USA there are more fixed than mobile connections mainly for cultural reasons (on of the few developed country with these characteristics). For these reasons the acceptance of a fixed and cheap telephony that compete especially well in long distance telephony has been high.
In the US, VoIP telephony has represented an opportunity for new players. Usually the old incumbents were not so enthusiastic in deploying this service, because it represents a destruction in their old fixed telephony model.
A good example of new entrance is Vonage, which tariff is a flat rate of USD 40/month, and acquired 35,000 customers (August 2003). VoicePulse have implemented this service with a flat rate of USD 35 and Packet8 with USD 20 but due to bad marketing has acquired only 3,000 customers.
As a general result about "10 to 12 millions have abandoned their second fixed telephone in 2 years in the USA". [38]
From this point of view we can think that until now VoIP telephony is competing with fixed telephony.
With the Wi-Fi technology has been possible to offer the first Mobile VoIP service.
In the US, Pulver Innovation in cooperation with BroadVoice Communication (fixed VoIP operator) have launched to the market "WiSIP phones", available for USD 250.
In this moment BroadVoice is offering two plans; "in- state plan" for USD 9.95/month and "unlimited USA calls" for USD 19.95/month. With any of these plans phone's price is only USD 150.

This new WiSIP telephony has still some technical features to be solved (already explained in this section), but now is already working, and is an opportunity for new entrance against incumbents, also in the mobile telephony. [39]

Also companies as Skype, that was offering already VoIP services, are lunching their first Mobile VoIP service called "PocketSkype". This service is a mobile version of the company's global VoIP service based on P2P software. This software is available for handsets with 400MHz processor with Wi-Fi capability and running Microsoft. But as this is based on P2P software, it is not possible to call anyone outside a certain group. Still this is not a killer application.

3.5.3 Japan

According the ministry of Telecommunications in Japan's fixed VoIP market it was estimated in a best case at the end of year 2003 5.32 millions residential users and 11,980 corporate users, and at the end of year 2007 it was estimated 27.88 million residential users and 21,550 corporate users.
In Japan fixed internet's usage is not as popular as mobile internet's. Anyway it has a broadband penetration higher than in USA.
Japan is already working in the Mobile VoIP through Wi-Fi techniques. Starting on March 2004 "IP talk" is offering the first IP mobile phone for 10% of the normal mobile price. Also Email services and mobile browsing are included in this packet for free. This represent a threat for old mobile operators and an opportunity for new entrances as IP talk. This service enhances the long distance telephony, especially to USA in this case. IP talk's tariff is as follows: to fixed lines Y8, to cell phones Y59, to USA Y24 (cheaper than to mobile phones!) and free to other IP talk subscribers.[40]
Also DoCoMo have announced its 3G/WLAN phone (N900iL). DoCoMo have entered to this game because it doesn't want to give wireless data market to only Wi-Fi devices (and new entrances as IP talk). DoCoMo's phone doesn't work with public Wi-Fi (M-zone) or with any network not installed expressly for the device. [41]

3.5.4 Korea

Korea is the country with highest broadband penetration in the world. For example in year 1994 there were only 2 ISP, and in year 2000 this number was increased to 82. In the year 2000 the number of Internet connections were about 19 millions, from where 4 millions were broadband.
As everywhere VoIP telephony was launched competing against big operators through cheap international calls. For example in year 2000 a typical international tariff from Korea Telecom was 726 (local won/min), while SK Telelink's tariff was only 288.
The revenue model at the beginning was getting revenues from advertising and VoIP telephony was free. In later years VoIP changed into a paid service (flat rate).
New entrances were a threat against big operators as Korea Telecom. But this operators' response was different than in other countries. Korea Telecom emphasized on ADSL offers rather than in competing in fixed telephony, enabling an even bigger increase in the VoIP implementation.
Just to give an example, Serone Tech. (new entrance) had in November 2000, 4 million customers.[42]

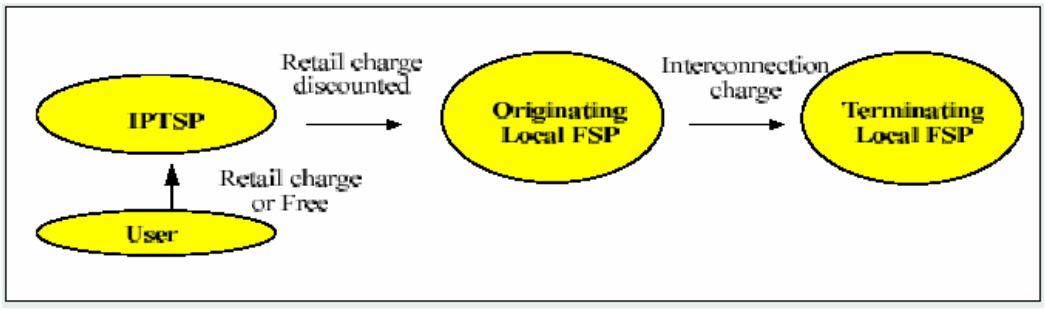


Figure 30 : In the case of Korea FSP could be Korea Telecom and IPTSP for example Serone [42]

3.5.5 UK.

In Europe VoIP has been implemented more in company level than in individual consumers. According IDC's European Manager Survey 2003, 12 % of companies in 10 EU countries have integrated their voice and data traffic. The high deployment of the VPN (virtual private networks) is thought to be the mayor contribute, because this enable that calls can be done for free within a company even in different locations. Also big players as BT are offering VoIP for business across Europe and in the UK.

Manufacturers as Nokia are expected to offer the first Wi-Fi/GSM phone before the end of year 2004, but this service has not been emphasized too much in Europe. According Donal O'Connel, Nokia phones' R&D VP, "the looming generation of Nokia phones will incorporate Wi-Fi, but simply as another option". [43]

At least there are already plans for opening doors to the Mobile version of VoIP. But the real deployment of this service is supposed to be bigger in other markets than in the European.

3.6 Push to Talk over cellular (PoC, PTT)

PoC is a half duplex transmission based service similar to "Walkie Talkie", where it is only needed to push a bottom in order to communicate directly to a group of people. PoC uses SIP (Session Initiation Protocol), which is the new standard for establishing multimedia, multiparty communication in IP-based networks.
We are going to first explain how this work according PoC technical specification v2.0 of Comneon, Ericsson, Motorola, Nokia and Siemens. [44]
We differentiate in terminology between PTT and PoC. PTT is push to talk service within a certain operator. PoC is the evolution of the PTT from proprietary approach to a more open approach. PoC is the next step with interconnection between systems.

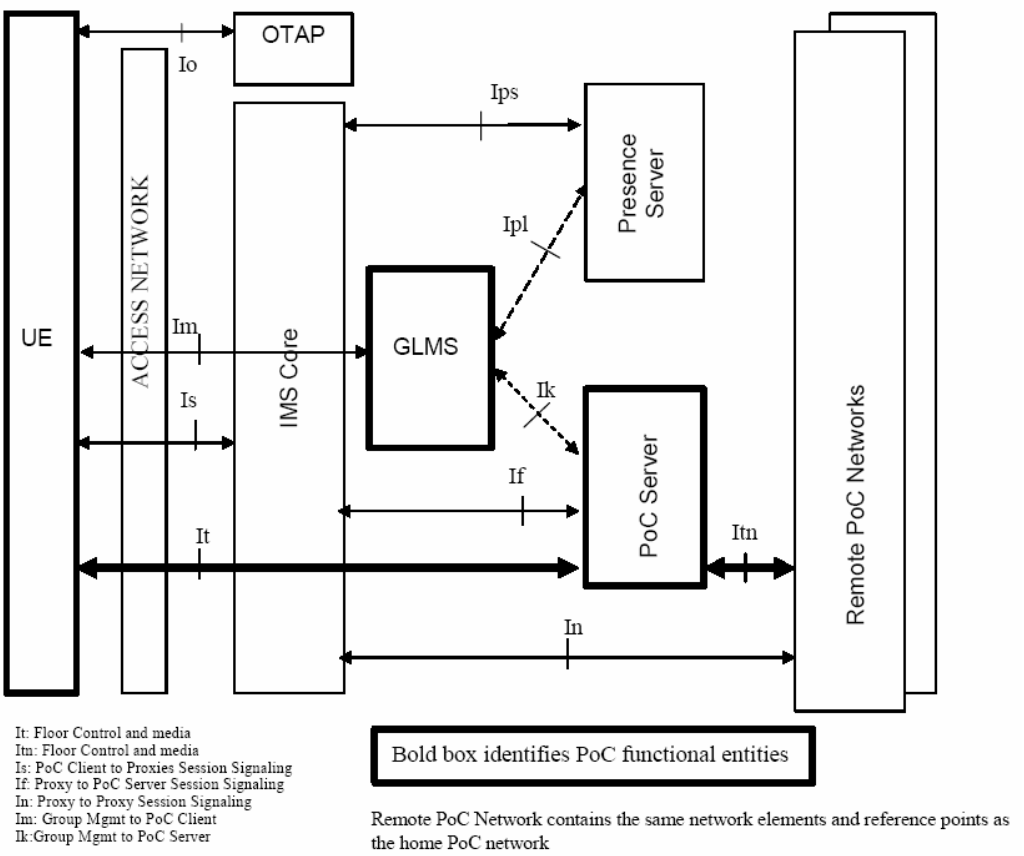


Figure 31: PoC functional architecture's elements and interfaces.[44]

Main functional elements in PoC are:

a) UE: user equipment (phone!) containing PoC feature (software).
b) IMS core: includes SIP proxies and SIP registers, in order to route SIP signalling, terminate SIP compression, authenticate and authorize, and report to charging system.
c) GLMF: Group and List Management Function to manage groups, contact lists and access lists.
d) PoC server: implements functionality needed in the PoC Service and in the PoC network.
e) Presence Server: Presence and PoC are two independent services offered to the UE. There is also a server for Presence.
f) Over the air (OTAP) Server: provides configuration parameters from service provider network for a PoC client. Also sends a WAP-push/SMS containing a binary coded XML to every UE with default factory and network settings.

3.6.1 USA's Nextel

There is already a proven success story: Nextel's. Nextel was the first operator to offer basic PTT services as an Enhanced Specialised Mobile Radio (ESMR). This feature enabled then to differentiate from other operators and maintain higher ARPU and loyalty of their customer. [26]

Nextel has nowadays 12.3 million subscribers, a 7.5% of the US's mobile market share. Nextel reached the highest ARPU within US's operators (USD 71/month/sub). The main weakness in Nextel's service is the limited coverage as nowadays there are no roaming agreements in PoC services. Also other Nextel weakness has been the low variation in terminal (only Motorola).
A study from Wintergreen (2003) shows that residential consumers are the one who uses at most this service (33%) followed by students (24%). It is estimated a market size of USD10.1 billions in 2008 (worldwide), but it is needed that this service is available anytime, anywhere.
In the following table we show a short history of this service's development.[45]

2004	Nextel reaches 12.3 millions subscribers with highest ARPU through PTT service.
August 2003	Verizon Wireless launched PTT service
2004/2005	Plans for launching PTT soon: Sprint PCS by the end of 2004, Cingular Wireless in early 2005 and AT&T Wireless by the middle of 2005
2004	Nokia launched world's first GSM based PoC enabled handset (5140).
2005	Nokia plans to provide PoC in all 2.5G and 3G handsets by 2005

3.6.2 Business and service architecture

The main characteristic of PoC is that it is an additional service, and it doesn't replace others, at least in the Nextel case.
In the actual architecture is a service that is cheap to deploy; only half duplex transmission and avoid interconnections to PSTN. Also it uses a technique that is easily available (IP).
But there is a clear need for inter carrier PoC, or interoperability between PTT systems. To implement this it is needed a clearing and settlement system for charging between operators (nowadays there are different rates for different operators).
As a VAS (value added service) PoC can be integrated with other service as the MMS.
PoC can be integrated with other services and producing synergy in these services. For example PTT/PoC will allow for expansion to Mobile Contact Management (MCM) service. This service can allow a management of contacts in terms of Presence and availability, location (LBS) and contact details. Presence detection comes from the ability to easily manage settings. In this way with availability management is possible to detect if people are present or able to communicate. Example application of this integration could be friend finder service or interactive mobile games. The ability of efficiently manage the communication experience such as add/modify/delete contacts will be particular important and will produce synergy with PTT systems. [46]

Requirements
Billing
Settlement
Protocol conversion & transport

Benefits for mobile operators
Additional revenue generation
Service offering differentiation
Cost reduction from PTT operation (instead of other services)

3.6.3 Roaming efforts.

There is an effort in standardization from the main players in the industry. Nokia, Ericsson, Motorola and Siemens have joined efforts in OMA for PoC standardization, in generally with Presence, Group and instant messaging.
The main manufacturers service status is the following:[26]

Nokia: PoC feature enabled in handsets
Ericsson: software application (Sonim)
Motorola: software application (Magic 4)
Siemens: in the process of launching

The main challenges of this group are:
-PoC server to server interface for global service interoperability.
- support both GSM/GPRS/WCDA and CDMA2000 radio technologies.
- harmonization to provide seamless operation in mobile and fixed environments.

Service's regulation could be a challenge, because there is no still clear regulation for IP telephony. This is an open issue today. Also this service is not able in an emergency (TETRA can be used for this purpose).

In this roaming effort Motorola has launched Cross Technology, which uses Motorola IP Multimedia Subsystem, and enable also push-to video service. (to send an image with voice). With this technology operators can negotiate network interconnection agreements. This solution is also interesting to enterprises with Wi-Fi networks, because PoC roaming can be expanded into Wi-Fi also.

3.6.4 Adoption of PoC

There is proved consumers' willingness at least in the case of Nextel in USA. In Europe doesn't exist any implementation of this service, so the European willingness to accept this service is now a question mark. Asian consumers are considered to be in between (USA and Europe) in their awareness of PoC services. [26]
Some studies say that download application (also via super distribution or MMS) could help in the service adoption.
Orange in the UK expect to have 1 million PoC customers within 12 months after their service launching, Orange is also planning to have PoC products with Microsoft platform.
The delay or latency level is of high importance when deploying this service. As an example the Nextel latency level is less than 1 s.
Also Nextel is launching other PoC related services as the new push-to-email, where a voice message can be sent via e-mail for only USD 7.5/month. Despite that some

critics says that this is just a glorified form of voice e-mail, it is clear that when deploying PoC service a vertical integration with other services is needed.
On the other hand Sprint have announced a commercial release of its new PTT-OTA (over the air), working also in CDMA networks.
Appart form these, there are also some competing technologies. The US's Fastmobile have released "fastchat" service, that is similar to OMA/3GPP PoC, but already available. This anyways has problems with performance and C&B issues. Also there is other solution based on P2P as the Skype service. These are not a big threat for PoC services, but are even good for competition. [26]

3.6.5 Pricing

When thinking in pricing it is needed to think that PoC service must be at least less than circuit switched voice. Pricing trend turns to deploy this service with usage tariff, but at an enough low price or also through flat rate pricing. At least as the technology is easily available, it is possible to offer low prices. If there is enough QoS the service's value preposition is good.
As an example of pricing we can talk about Nextel's push to talk or "walkie talkie" functionality. The basic charge is USD 0.2/ min, or USD 20 /month. Also it is possible to choose a tariff of USD 5/month with USD 0.1/min. This service works also internationally in all Nextel's countries: US, Canada, Argentina, Peru, Brazil and Mexico within iDEN subscribers. [30]

3.7 Mobile Browsing

According to a MoCoBe's survey there is no clear correlation between location and type of content or usage. This is a quite important observation because means that browsing depends on the personality rather than on the location. People used to listen to music at home are going to listen to music at work also if it is possible. [47]

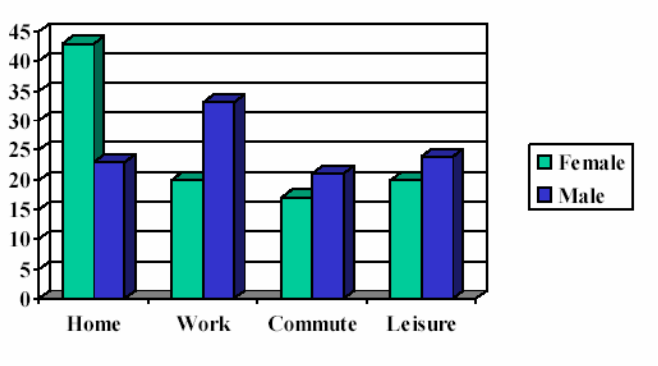


Figure 32: Japan's mobile internet [48]

As follows we are going to compare worldwide i-mode v/s European WAP. It is clear that i-mode in Japan has been much more successful until now than WAP in Europe. Despite that number of nominal users are similar (and Europe is much bigger), the i-mode's usage and ARPU are higher (numbers in following sections).

i-mode	Users (millions)
Japan	42
Europe	3*
USA	Beginning

*July 2004 [7]

WAP in Europe	2002	2003
Num of phones	34 m	47 m

This was the situation in the year 2000. It is possible that nowadays things have changed, but it is useful to see at least how trend have developed. [49]

60 %	Japan	i-mode
21.5 %	Japan	WAP
12.5 %	Korea	WAP
5 %	Europe	WAP
0.9%	USA	WAP/PALM

As we already mentioned, the 83% of i-mode users say that their main reason for i-mode use is e-mail application. But there are also other reasons (Music 45.8%, paid content 37.3%, etc). This could means that a cheap messaging application has enabled the popularity of i-mode in Japan, but it is not the only reason. In Europe, when WAP was deployed, SMS has enabled already a cheap messaging service. For this reason could be especially interesting to see how i-mode has developed in Europe.

3.7.1 Japan's i-mode

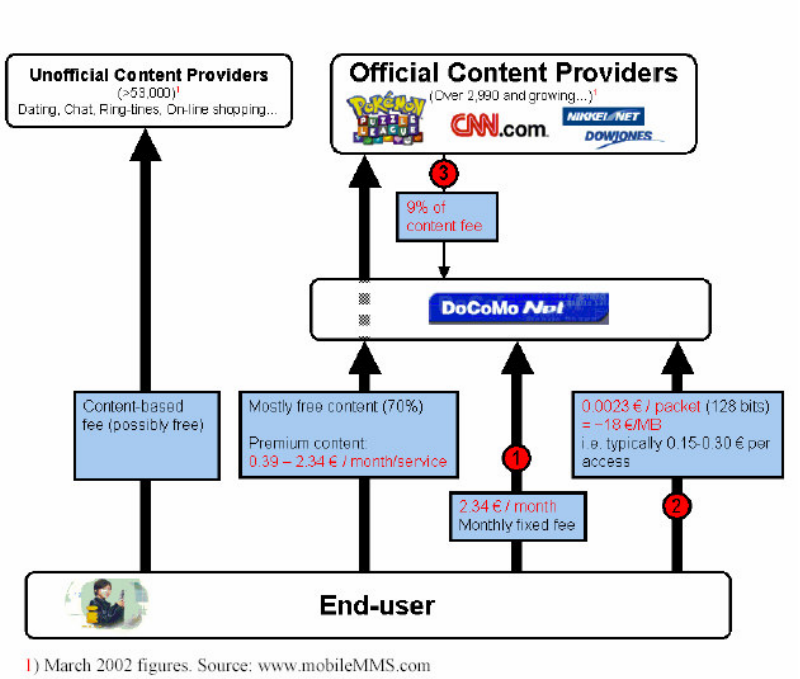


Figure 33: Japan i-mode value system. DoCoMo does not act as a Content Provider, and gets its revenues mainly for traffic rather than from content.[13]

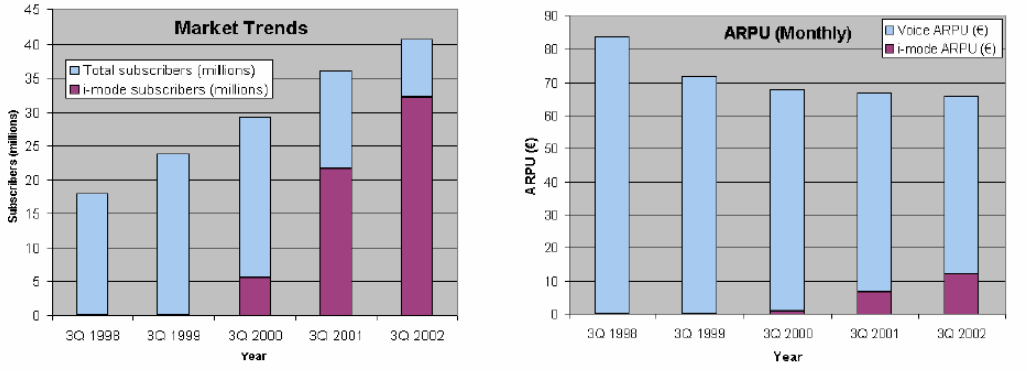


Figure 34: subscribers and ARPU of Japan's i-mode [14]

Mobile internet is dominated by i-mode in Japan. I-mode is not like WAP; is more a service than a protocol. As in Japan telecommunications are operator centred, services are more services than protocols. I-mode is similar than Vodafone live, that uses WAP.

In Japan NTT DoCoMo has a 60% of the i-mode market share. The rest is shared by J- phone Vodafone and KDDI.
Apart from the cheap messaging possibility i-mode has been successful for many other reasons: [4]
-decision to choose cHTML, that remains internet's HTML.
-packet based billing (not time)
-portal & revenue sharing models, that involves Content providers.
-low PC & internet penetration when i-mode was launched

-colour display handsets
-Availability of 'i-appli' (java applets), enabling games and info from web.

The other key fact in Japan in order to understand the success of i-mode is to understand that Japanese market is quite homogeneous. This have bad consequences as the innovation is restricted (eg. screen size are the same, unilateral billing system, "antenna" issue, etc), but also there is harmony when launching services, and services can also be launched in a quicker way.

In the table there is a general comparison of Europe and Japan. Japan is much more homogeneous.

	Num of operators	Population
Europe	50	375 m
Japan	3	130 m

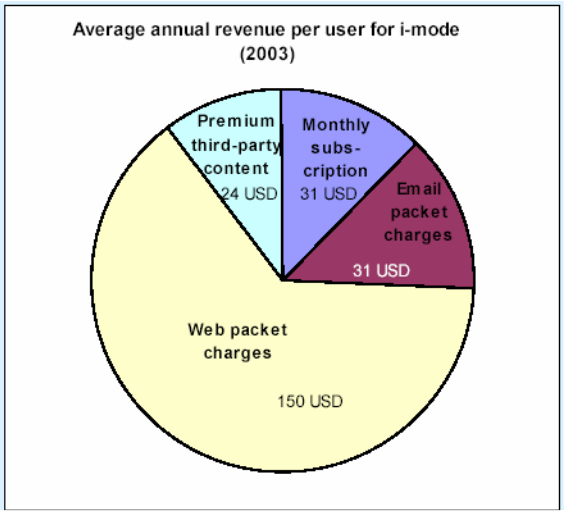


Figure 35: i-mode's ARPU [13]

For this and many other reasons i-mode has reached high level of ARPU, especially in the case of web packet charge.

3.7.2 UK, Europe

In the UK and also more generally in Europe we can talk about two main unexpected events: the SMS's success and the WAP's failure.
According to ITU main reasons for WAP failure are:

- delay for download
- ineffective billing models
- lack of content in WML (WAP's format)
- inappropriate (monochrome!) interface for web viewing

Also as a joke it is said that WAP means "where are the phones", to explain that one of the main reasons of failure was the missing or inappropriate handsets. [4]

But now WAP is coming again in its version WAP 2.0, that tries to improve the mistakes of the past.

Vodafone have launched its service “Vodafone live!” (that uses the new version of WAP) in many countries, and of course especially in the UK.
Vodafone live! “enables customers to use picture messaging, download polyphonic ring-tones and color games, and browse branded infotainment from integrated camera phones, through an easy to use icon-driven menu” (description from Vodafone’s web page). Also offer other extra services and quality if it is used with 3G networks.
This service has reached a certain success in its beginning, getting over 1 million customers in just 6 months. At the beginning Vodafone live was offered with 3 phone models (i-mode offered with only one), with camera and MMS feature. Its marketing has been effective and its pricing model clear.
Other service based initiative in Europe has been the introduction of i-mode. It has reached a relative success in some countries as France and Spain, reaching after one year 400,000 and 500,000 customers respectively. As we see i-mode had a slow take up in Europe, due for some problems: [4]
-lack of camera
-lack of MMS
-unclear pricing model

Also in Europe is important the handset’s brand. At the launch of i-mode big manufacturers didn’t join this service, so that customer bought a handset for i-mode rather than for the handset (example of i-mode manufacturer is Vitelcom, Spanish-French-German company). Now this situation is changing, because Samsung, Nokia and Siemens are already releasing i-mode phones.

WAP usage in UK	Sep 02	Dec 02	March 03	June 03
Millions of pages/day	11	14	18	26

3.7.3 WAP v/s i-mode

We can compare WAP and i-mode from at least two different points of view. The first one is Japan’s i-mode v/s Europe’s WAP. Here it is clear that i-mode won the fight. In the second scenario we have in Europe WAP represented by services as Vodafone live! v/s i-mode.
First of all, we will talk about Japan’s i-mode v/s Europe’s WAP. When both teams (WAP’s and i-mode’s) were working they had similar goals. We can think why one team was successful and the other wasn’t. Reasons of this are quite available and depend on the cultural and background matters.
WAP group focused on the protocol rather than in a concrete service. In this group was not present the interest of operators or of content providers; there was not any central billing system plan either). I-mode’s team was much more integrated, and was service centred, and operators had a central role (this is easy when there is only 3 operators, with the high dominance of DoCoMo). WAP forum didn’t had capacity to control most of the issues DoCoMo could coordinate, as for example handset and content availability. [4]
In other words, WAP was a protocol without service, when i-mode was already a service.
Also from the point of view of pricing WAP was deployed with time pricing, while i-mode with flat rate and block pricing. We can say that from this point of view i-mode

is more similar with GPRS, which charge "per transaction" base (eg. Finland's Gerrimap charges € 0.4 per map search).
In the intra Europe comparison we can say that Vodafone live! has been more successful than i-mode in the launching period. It seems that i-mode has learned its mistakes and has reached 3 millions users in Europe at the end of June 2004 (especially in Spain and France). In Spain i-mode has been launched by the biggest operator (Telefónica) and in France by Bouygues Telecom. I- mode alliance has announced 3 million users after announcing 4 months before a user base of 2 million (1 million users in 4 months). This represents a quite fast growth.
Both i-mode and Vodafone live! have the same business model: [4]
-use of portal
-micropayment system
-revenue sharing model
-division of official/unofficial sites
-dedicated handsets

	i-mode in Europe
Users (end of 2004)	3 millions*
Operators	Base(Belgium), Telefónica (Spain), Bouygues (France), E-Plus(Germany), KPN Mobile (Netherland), Wind (Italy)
Mean ARPU	6-10 €/month

* July 2004.
Table: i-mode in Europe.[50]

WAP	**i-mode**
39% of world's internet users	60% of world's users
Sites based on WML	Sites based on cHTML
Circuit switched	Packet switched
Service business oriented, work oriented	Service user-oriented, fun oriented
Anyone can produce content (menus)	Anyone can produce content, but DoCoMo operates content menu
Open specification	Service developed by DoCoMo
Time pricing	Flat rate /block pricing

Table: features comparison between WAP and i-mode [51]

3.7.4 Future of WAP

In the UK there were 1 billion WAP pages impressions in 2002, with a growth of 18% in less than a quarter of year. This number was expected to reach 8 billion in 2003.
In France, for example Orange has reported in May 2002 10 million minutes of WAP browsing. This amount has reached 25 millions in December 2002. This means 130% growth in 6 months.
It is clear that WAP is not dead, and can increased in the future its usage, especially through other services as MMS, email, mobile wallet, etc.
In the following version WAP 2.0 there are same important changes that can increase WAP performance. In terms of transport layer there is a migration from the old WAP system to the wireless TCP/IP (wTCP/IP), enabling the download of larger multimedia file.

So we can say that WAP 2.0 introduces 2 new technologies: new mark-up language XHTML and transmission protocol xTCP/IP. This would enable WAP 2.0 to discover new services.
As i-mode have announced to use also the XHTML language, WAP 2.0 can unify WAP and i-mode. This model can change the actual competition between WAP and i-mode, enabling a richer interaction and synergy between these two services (i-mode and Vodafone live-like services). [52]

3.7.5 WML, cHTML and XHTML

WAP has used from the beginning WML (WAP markup language, HTML based language). WAP has not been so popular for reasons explained before. Within the reasons we can mention the WML protocol's imperfections. WML does not ensure for example consistent layout across different devices.
As one of i-mode success factor we can mention cHTML, developed specially by DoCoMo.
Main WAP players have developed a new HTML language called XHTML, which is supposed to be the language of the next generation WAP 2.0. This language is supported by WAP Forum and by W3C.
Even i-mode have announced be joining XHTML, fact that can mean in the future important changes in the WAP v/s i-mode competition.
In i-mode's cHTML there are some imperfections, which are improved in XHTML:[53]

-cHTML is not a W3C standard (World Wide Web Consortium)
-does not support cascading style sheets
-can produce inconsistent results from browser to browser
-lacks the XML header and DTD specifier

With the new generation WAP 2.0, WAP is expected to reach 200 million users in Europe by the end of 2004 (research of In-Stat group).
In Figure 36 we can see in the WAP 2.0 browsing. Portal Provider is different from Operator, but could be the same company. Anyway charging model is double to end user.

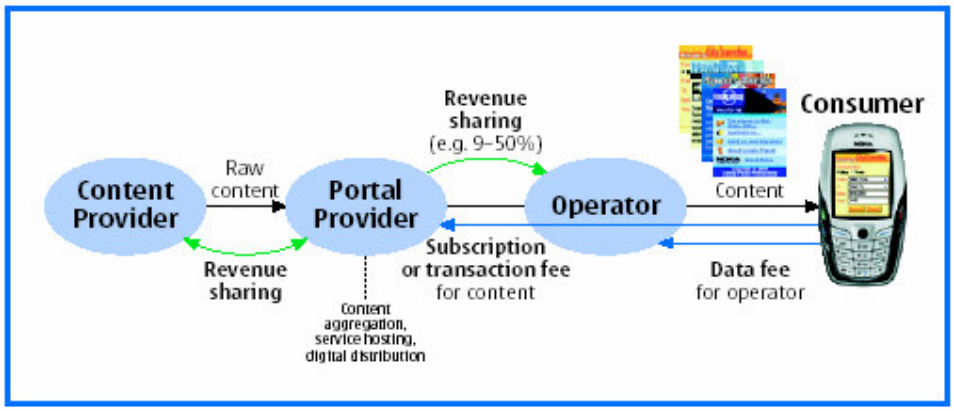


Figure 36: dual –mode browser's (XHTML/WML) value system.[52]

3.7.6 Future of browsing in Europe

We will do a brief description with tables of the future of browsing in Europe.
We separate WAP 1.x and WAP 2.x browsing from PDA browsing. WAP 1.x refers to the early black and white WAP using GPRS connection. In WAP 2.x is considered both advanced coloured WAP 2.0 (Vodafone live! or O2 Active) and i-mode due to the convergence of i-mode and WAP (XHTML). PDA refers to handsets as a Nokia Communicator or a RIM Blackberry.
In these tables we can see that browsing for content is less profitable in Europe than Messaging. Anyway we can see that the convergence of WAP and i-mode will give new forces to both WAP 2.0 and i-mode markets. We can see that in ARPU and in usage WAP 2.x browsing is supposed to dominate in mobile browsing markets.[5]

Penetration of handsets

Browsing	2004 E	2006 E
WAP 1.x	72%	88%
WAP 2.x (and i-mode)	**28%**	**68%**
PDA	5%	14%

Active users

Type of browsing	2002	2004 E	2006 E
WAP 1.x	8%	13%	7%
WAP 2.x (and i-mode)	**0%**	**8%**	**24%**
PDA	0%	2%	4%

Browsing ARPU (€/month/subs)

Browsing type	2002	2004 E	2006 E
WAP 1.x	0.12	0.08	0.07
WAP 2.x (and i-mode)	**0**	**0.03**	**0.11**
PDA	0	0.02	0.04
Total	**0.12**	**0.13**	**0.22**

3.8 Mobile payments and authentication

M-commerce (mobile commerce) has its roots in the e-commerce and in the business models that fixed internet has enabled. E-commerce has been popular especially through credit card. For example, Visa has about 50% of market share of Internet payment in the US market (see Figure 36).

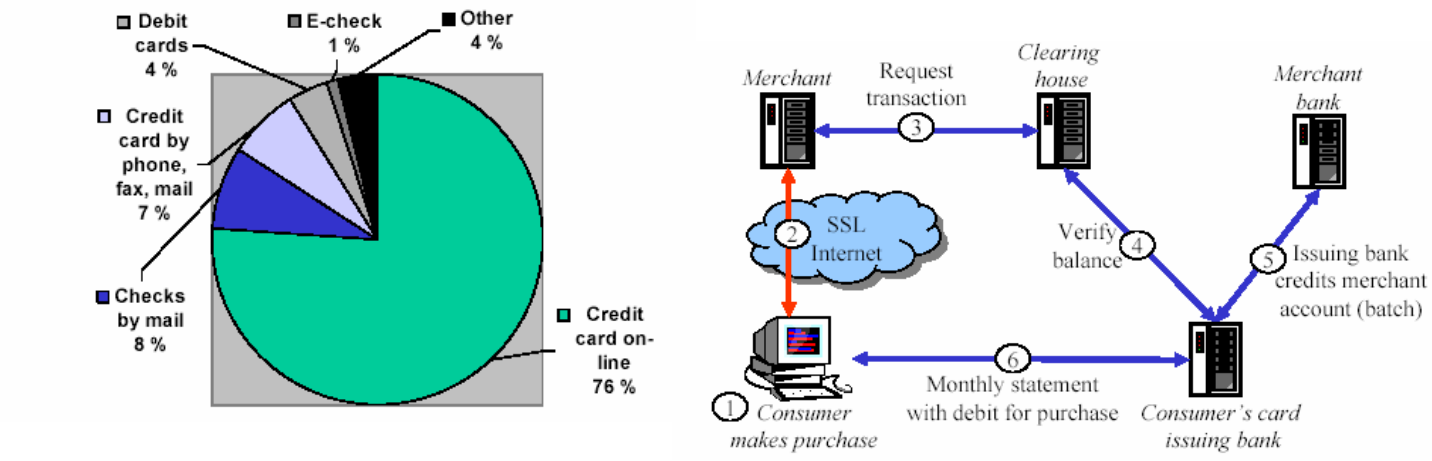


Figure 36: E -commerce
Left: ways of usage in the US market.
Right: typical e-commerce transaction: players in the value system.[48]

At the moment there are 3 expected applications in the mobile payment arena. Until this moment the mobile payment usage is not so extended (more in Korea/Japan than in Europe/USA), but can be developed specially through security, authentication and ubiquity of mobile phones (see Forrester research, Figure 37).

Table 1: Inhibitors to the Growth of M-Commerce

Obstacle	Phone (%)	PDA (%)
Credit card security	52	47
Fear of "klunky" user experience	35	31
Don't understand how it works	16	16
Never heard of it before	10	12
Other	11	13

Source: Forrester Research

	Korea	Japan	UK	USA
Micro	X	X	X	X
e-wallet	X	X		
PoS	X			

Fig 37: security as first cause for not using m-commerce.[54]
Right: different applications in different countries.

Mobile commerce applications: [5]

a) Micropayments:
This is the first mobile payment application to take into use. Usually works for small items online via monthly phone bill or prepaid credit balance. As an example we can talk about online ticketing or the purchase of CD from operator's WAP sites.

b) E-wallet
This is the next step with virtual money effectively stored in a phone, protected by a PIN. The balance can be charged, perhaps via SMS or via WAP (via mobile banking service) and payment can be done via SMS, infrared or Bluetooth.

c) PoS transaction
This is the last step for mobile payment, where the phone essentially becomes a credit card rather than e-wallet, allowing for paperless transaction between accounts (paying bills) to be authenticated in a point of sale terminal.

We explain briefly here from the technical point of view how an m-commerce service could be deployed using digital money.

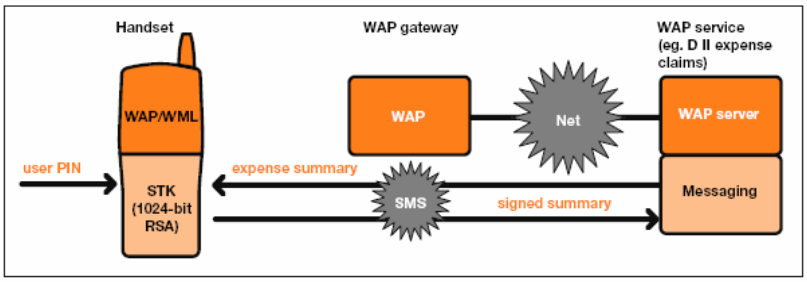


Figure 38: Vodafone/Smartrust schematic [63]

In Figure 38 we can see the pilot plan from Vodafone and the UK government to use digital signature technology. It is used SIM-based digital signature technique (here using Sonera's Smartrust platform) allowing to browse and select from WAP sites and digitally sign information sent from WAP site via SMS.

The main problem for the deployment of an extended mobile payment service is the slowness in the agreements of necessary standards/parties and security issues.
In a general way, banks need mobile operators to implement mobile payment, because mobile operators have already a working billing systems with a customer base. Also the key of the M-commerce is in choosing right partners.
In the following lines we are going to see some examples of different deployment of mobile payment in leading countries.

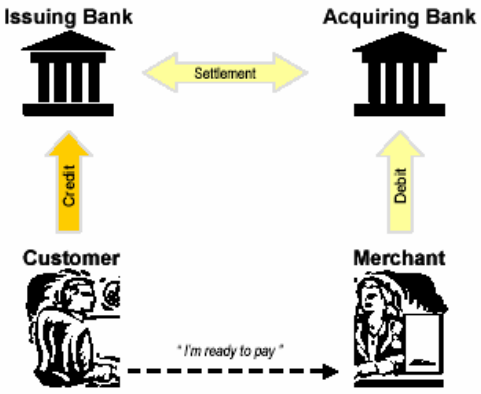


Figure 39: typical M-payment transaction flow [55]

3.8.1 Europe

In Europe the mobile payment has been slower than in Japan or Korea, probably because agreements are more difficult to reach.
In Europe there are two kinds of service providers in m-payment: operators and independent m-payment providers.
As an example of the second type providers we have the Germany based Paybox (working also in Austria, Spain, Sweden and UK), and the Swedish Mint (working only in Stockholm).
Paybox uses an Integrated Voice Recognition (IVR) based system; a user making a transaction provides his number to the merchant, who calls the IVR with transaction data. The user finally receives an IVR call asking for a PIN code.
Services as Paybox and Mint are based on the mobile number and on a unique PIN code, but they use very limited security features.
Paybox has already 750,000 users and about 10,000 available acceptance points. Mint has 12,000 users and 30,000 parking spots, 100 retailers and other acceptance points in Stockholm. (August 2002)
Sometimes authorities play an important role in this service. A good example of this is in the Spanish market, where anti-trust authorities have forced Telefónica to open a planned m-payment service to subscribers of other operators. This has produced that "Mobipay" service covers 100% of the Spanish mobile phones and 80% of banks' customers. Despite that in this service all 3 kind of transaction are implemented, only micro-payments are used.
Other operator that has implemented m–payment is Vodafone. Vodafone with the cooperation of T-Mobile has developed a micro-payment platform called "m-pay" for purchase of content from operator's website and Vodafone live! sites.
Many operators have already deployed some services: Vodafone Germany began offering tickets to sport events and concert via SMS, Sonera has offered in Helsinki's airport to buy a Coke via SMS and it also has implemented mobile payment for parking and tram tickets, Telenor from Norway have offered cinema tickets via SMS, etc.
As now 50% of mobile phones have WAP in Europe, m-payment should be easier to implement.
In February 2004 Orange, Telefónica, T-Mobile and Vodafone have formed a new association (Mobile Payment Service Association) to drive interoperability of mobile payment solutions. Also KPN, mmO2 and 3 have expressed their willingness in joining this group.[63]

Service	Technical requirement	2003 estimation	2007 estimation
Micropayment	WAP	58%	93%
e-wallet	WAP 2.0	9%	79%
PoS	Java	18%	83%

Tables: m-payment services' penetration according their technical requirements. (Source: CSFB estimates, [5]).

ARPU estimations (€/sub/month)	2003 E	2005 E	2007 E
Micropayment	0.02	0.05	0.05

e-wallet	0	0.01	0.13
PoS	0	0	0.15
Total	**0.02**	**0.06**	**0.32**

As we see in ARPU estimation, m-payment is not expected to generate a lot of revenues to mobile operators for several years and only with the PoS adoption could be possible to get some higher revenues. For this purpose greater security is needed. (ARPU is higher than mobile browsing but much lower than messaging services in Europe).

3.8.2 Korea

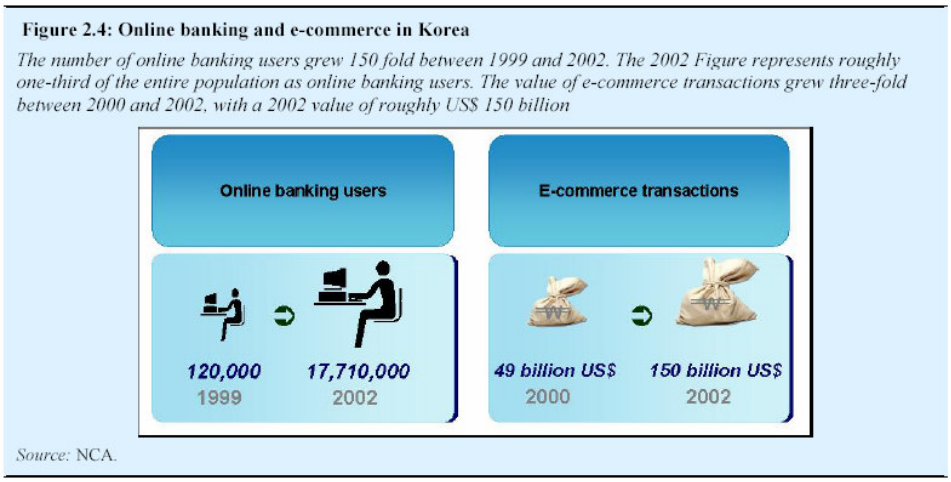


Fig 40: E-commerce; Koreans like to pay online. [3]

All Korean mobile operators allow their subscribers to make payments via mobile phones. Korean can practically buy everything via mobile phone, from coffee at a coffee shop, snacks at convenience stores or larger purchases at department stores. At the request of mobile operators, manufacturers have built in smart-chip slots on phones that can be used for specialized services (they did not have SIM card that could be used for credit information).
There are more than 470,000 locations nationwide that will accept m-payments.
In order to facilitate mobile commerce, credit card companies and mobile network carriers formed an alliance and began issuing credit cards into subscribers' handset.
M-commerce services in Korea are: SKT's "Moneta" with over 1 million subscribers, KTF's "K-merce" with over 500,000 and LG Telecom's "Zoop", which is also expanding quickly.
As an example Moneta work with RFID chips. User has to simply wave the mobile phone in front of the Moneta's receiver placed usually next to the cash register. The same system is used when paying for the public transportation and in petrol stations.

In addition to point of sale transaction, operators have introduced mobile banking (PoS). SKT's "Network Money" (NeMo) uses a multifunctional smart chip to store online banking information securely and allows making payments to others via mobile phones. Through this money transfer via mobile settlement they avoid queue in banks, typically long at the end of the month. Mobile banking transactions doubled

from 2002 to 2003. In December 2003, Korean mobile users checked their balance or made a banking transaction 2.56 million times (Dec 2002 only 1.1 million). [3]

3.8.3 Japan

Since 1999 e-ticketing has been popular in Japan via Internet, but the mobile ticketing has been used only from 2003.
As an example we can talk about PIA Corporation's model. In this model there are "Digi-Pockes", virtual pocket where tickets are saved or transferred between users, and "DigiGates"; automatic entrance gate accepting all kind of tickets.
Tickets can be bought:
-directly through mobile handset
-through PC using smartcard
-through ticketing machine
-from ticketing counter
According PIA's statistics, 15 % of tickets are sold through Internet, of which 66% through PC and 33% through mobile phones.
This system enables a value chain directly between shops and organizers. PIA has a ticket issuing fee of JPY210 per ticket, when the cost of sending paper ticket is JPY 600 per ticket.

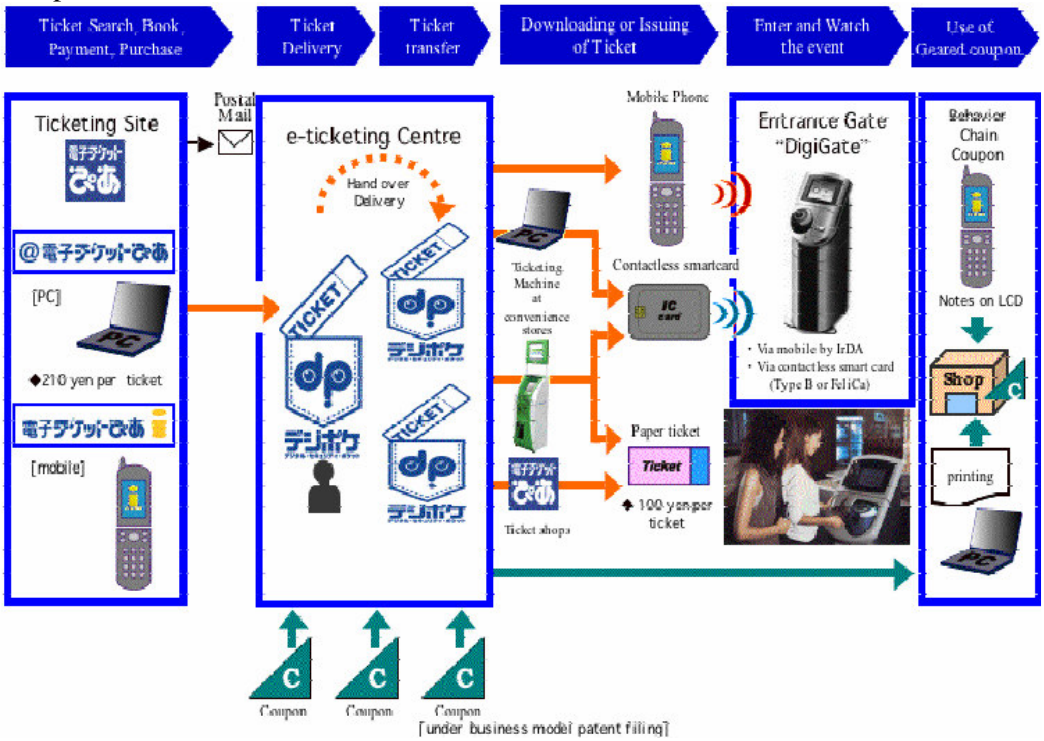


Fig 41: E ticket and E coupon from Pia Corp. [2]

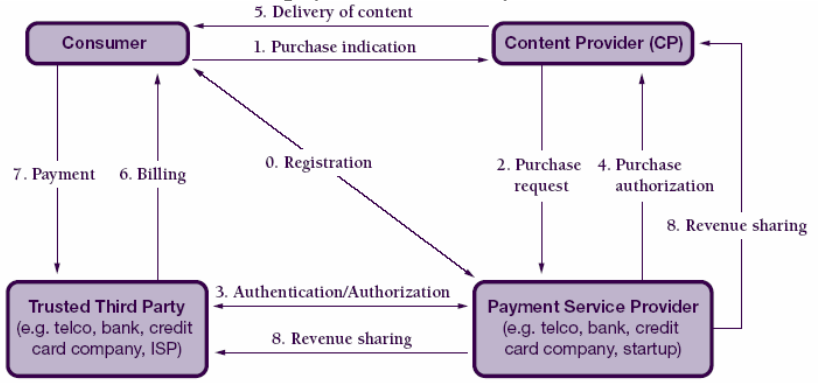
Also in Japan IC cards for public transportation have been quite popular. These cards, done by Sony, were promoted by DoCoMo as "FeliCa cards", and are commonly used to ride JR railway lines. In addition 10 million Japanese use "Edy" (euro-dollar-yen) prepaid cards for the same purpose.
FeliCa card can be used as ticket or cash for services as public transportation, concert tickets, etc. KDDI and Hitachi have also developed handsets with FeliCa card.

SIM version in 3G is known as the UIM (universal identity module) will enable secure user identification, allowing that a wide variety of content can be stored in the future, such as prepaid coupons, and credit card and roaming information (as in Korea, SIM was not used before).

In July 2004 it is planned i-mode FeliCa service for mobile wallet application, used in both 2G and 3G phones. This can enable a wider spectrum of services: train card, credit card, debit card (e-money) and personal identification card.
As a conclusion, in Japan micro-payment is widely used and e-wallet is just beginning. There is no still PoS transactions. [2]

3.8.4 Different solutions and value systems.

First of all, we describe m-payment's value system.



Criteria	Banks	Credit card firms	Mobile operators	Payment start-ups
Motivation	*Fear of staying behind*	*Add a new channel*	*New revenue and services*	*Business opportunities*
Mobile services skills	○	○	●	◔
Financial services skills	●	●	○	◔
Micro billing capabilities	◔	◔	●	●
Macro billing capabilities	●	●	○	◔
Large end-user base	●	●	●	◔
Large merchant base	◕	●	◔	◔
Move quickly	◔	○	◑	●
Able to expand quickly	◕	●	◕	◔
Sample company	SEB	Visa	Orange	Paybox

Minimal capability ○ ◔ ◑ ◕ ● Robust capability

Figure 42: general value system in m-commerce.[56]

It is possible to see in Figure 42 main players in the value system. As there are many solutions, the Payment Service Provider could be a telecom operator, a bank, a credit card firm or a start-up firm as Paybox. It is interesting to see that while Banks and Credit cards have macro-billing capability; mobile operators and start up firms have a

better micro-billing capability. Here is good to remember that banks don't get much revenue from payments, and it is not sure if they are willing to do big investment in this area.

Now we describe briefly here various vendors' payment solutions:

a) **Encorus**: which deploy an e-wallet through a Wallet Server.
b) **Enition**: network level product to be integrated within CP's and SP's network infrastructure.
c) **iPIN**: end-to-end e-payment platform specially strong in micropayments.
d) **Portal**: portals' software develops billing software for CP and SPPortal's payment module interfaces with Infranet software.
e) **Rapsodia**: generic, open and re-usable platform that enables telcos to provide SIM toolkit services.

Characteristics		iPIN	Encorus	Enition	Portal	Rapsodia
Transaction criteria	PPV	●	●	◑	◑	◑
	PPU	○	○	●	●	○
	Recurrent subscription	●	◑	◑	◑	◑
	Pre-paid	●	●	◑	●	◑
	Post-paid	●	●	●	●	◑
	Direct debit	●	●	○	◑	●
	P2P	●	●	○	○	◑
Content criteria	Digital goods	●	●	●	●	◑
	Hard goods	●	●	◑	◑	◑
	Tickets	◑	◑	◑	◑	◑
	Votes	◑	◑	●	◑	●
	0-0.1 euro	○	○	●	●	○
	0.1-10 euros	●	◑	◑	●	◑
	>10 euros	◑	●	○	◑	◑
Level of upgrade/ customiz-ation needed	For consumer	Low: need to open/activate an account	Low: need to open/activate an account	None	None	High: May need to upgrade the device
	For content provider	Low: APIs are provided for quick integration	Moderate: APIs to integrate on the CP site	High: need to add an Enition box	Moderate: Java APIs to develop transaction dialogue	Low
	For Payment Service Provider	High: full payment platform to implement	High: full payment platform to implement	High: Enition box to plug to the SI	Moderate: if Infranet 6.2 is already deployed (ICC module included)	High: ASP platform to deploy and customize applications to the needs
	For Trusted Third Party	Moderate: plug to the billing system, bank account or prepaid balance	Moderate: plug to the billing system, bank account or prepaid balance	N/A	N/A	N/A

Table: different solution with its characteristics [56]

3.9 Pre-paid data and Anonymous content

In order to see how prepaid data market can work, we have to see first how prepaid voice works in different countries.
According IDATE, percentages of prepaid from total mobile users are: [59]

Germany: 50 %
UK: 70%
Italy: 87 %
USA: 15%
Japan: 5 %

Also is good to compare here the general ARPU, in Japan much higher than in Europe (Japan USD 80/month, Europe USD 30/month). We also know that generally prepaid's ARPU is lower than postpaid's ARPU. But also consumer acquisition costs are lower in prepaid than in post paid (figure 44).
In Finland, prepaid market is also very low (figure 43). Despite that prepaid's ARPU can be lower, prepaid can stimulate the usage of many data services that in a longer period can return more revenues to operators.
In these lines we are going to try to find out how prepaid-content usage works in different markets.

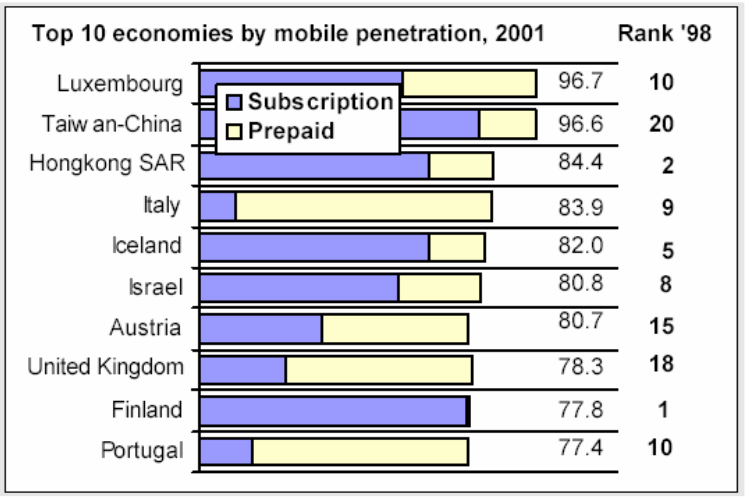


Figure 43: prepaid situation in year 2001 [58]

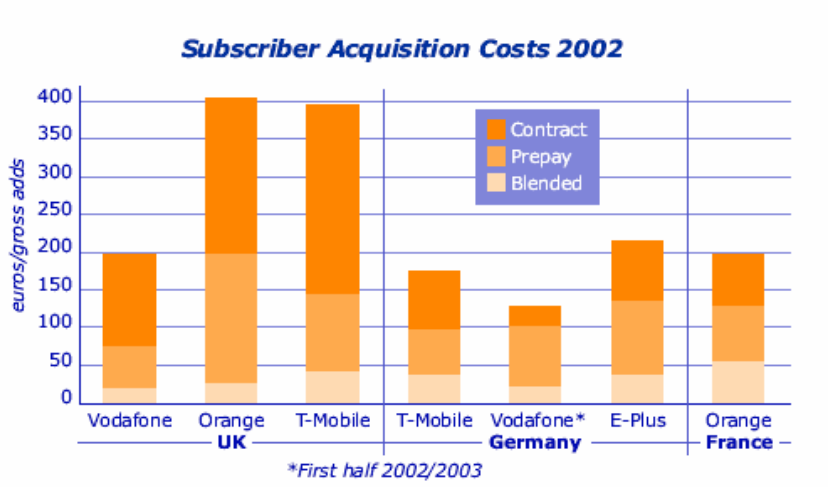
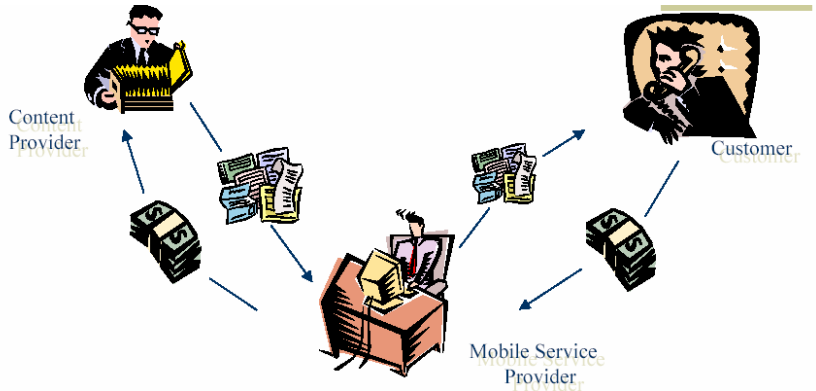


Fig 44: subscribers' acquisition costs in European countries. Typically less in prepaid than in post paid. [59]

Still prepaid is a voice service, but little by little is coming into the data sector with services as SMS and MMS.
First we are going to see what the ways of prepaid payment are, and what reasons for implementing prepaid services exists.

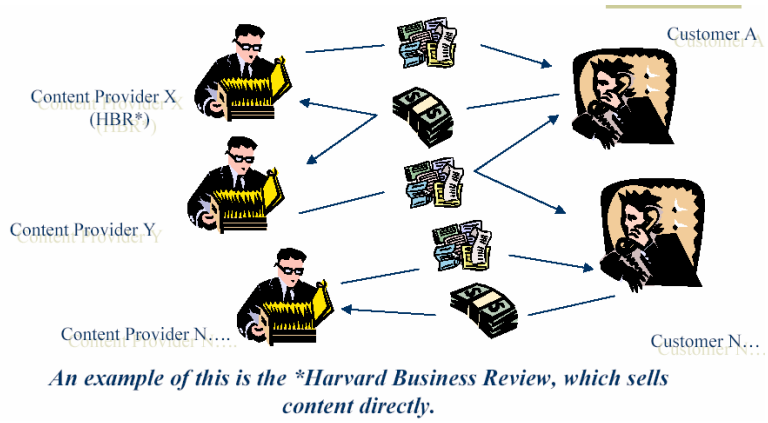
3.9.1 Prepaid systems.

a) Phone bill model or prepaid card model (Figure 45)



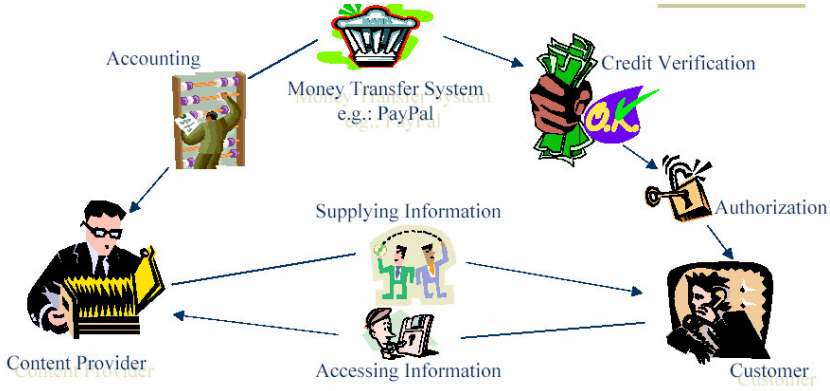
Imode in Japan is an example of this and they apply a flat 9% surcharge to all the content they re-sell.

b) Debit model: sell content directly (figure 46)



*An example of this is the *Harvard Business Review, which sells content directly.*

c) person to person model (figure 47)



Some systems using this approach are Qpass and Aether Systems.

[60]

3.9.2 Reasons for prepaid

Until now prepaid voice is implemented in order to get more customers and increase mobile penetration in a market. Research firm IDC identified that in USA youth market drive prepaid services. According to this research, despite that this sector has lower ARPU in the US, it is quite useful to reach this sector that by other means could be unreachable, and once prepaid customers are active they shift to postpaid.
Some people like prepaid also because they see in prepaid an ability to control money spent by their children. Despite this, prepaid customers are not willing to accept limited service options.
The fact that youth are drivers of this sector is interesting, because normally youth are drivers of new services as MMS, and reach this sector could be interesting for reaching higher penetration of new services. This means that new services can be easier introduced to a certain market through prepaid model.

Example of services where prepaid can affect in increasing their usage and in their introduction to the market are: ring tones, picture messages (MMS), restaurants,

movie/games tickets, vending machines, local transport, CDs and books, flowers, parking, buying on-line content and location-based services.
If we think in the Finnish market, someone can say that it is not needed to implement prepaid, because mobile penetration is already high. But this is not necessarily true, because without prepaid could be slower to introduce some new services. And once they are introduced in the market, prepaid customer turn into post paid customers with higher ARPU for operators.
Examples of incentive for new services' usage we can give from USA. Starbucks implemented prepaid cards for sales in their stores, or Napster have offered prepaid cards allowing teenagers without credit cards to buy music on the web (USD 14.85 for 15 downloads). These examples can also work in the mobile data case.

Also from the operator's point of view, prepaid could be a way to reduce cost of transaction. When talking about voice services there is no any problem, but when there are many small transactions due to all kind of data services, the cost of C&B can increase a lot. If the number in transaction increase (for example, double than before), the operator would have probably a problem with its billing system. With prepaid system there is no need for a complex billing system.
Of course, bad implemented prepaid methods can even increase costs, if customers get used to do too many small prepaid payments (too many small cards).

On the other hand, prepaid system could enable to minimize revenue leakage (due to people that don't pay their bills). For example, during year 2002 AT&T reported USD 300 millions in uncollected revenues.

3.9.3 Problems in prepaid

Unfortunately, from regulator's point of view, prepaid can bring some problems. Anonymous content and voice is actually preferred for many people, also for criminals and illegal aliens. For this reason some governments are forcing operators to collect customers' data. As an example in 2004 Switzerland will require users to supply their addresses when buying prepaid cards, as was known for authorities that members of al-Qaeda have used prepaid cards.[59]
For example in USA, AT&T has launched some prepaid cards to incentive online web purchases such as video games, music, cartoons and other low price items (especially focused for young people, that don't have credit card) separated by sites (Disney, Shockware for ring tones, etc).
The main controversy was that in AT&T some people wanted to tailor these cards to kids to offer internet pornography and gambling (bet) even against the will of their parents. They see this young segment as a possible source of profits, because according Robert Leathern, analyst of Jupiter Research, in prepaid market there is an "enormous appeal in anything where people wish to remain anonymous".
Finally AT&T decided not to offer these cards because operator's brand stands for "quality, integrity and family values" (Kevin Crull, senior of AT&T Consumer), and this service could mean a damage in operator's brand.
AT&T is hoping to get revenues from non- adult subscriptions (according "Jupiter") of USD 6 billions by 2006 (cards' prices are USD 9.99 and USD 29.99), despite that some experts are skeptical because cards work in only one site and also because there is a limited number of content providers.

Prepaid can foster the usage of many services, especially in the younger segment, in both fixed and mobile environments. [61]

3.9.4 Prepaid customers and characteristics.

According Teradata Consulting research (February 2004) main prepaid customers of both voice and data are. This represents US market's reality, but can also be applied to other markets.[59]
a) **youth market**: as a credit challenged group with their parents' ability to pay. This is an interesting segment that has ability to pay but need parents' control. Also some youth people without parent's control but with a need of credit self control.
b) **occasional user**: older users that are normally technology adverse, but are ready to spend high price when needed (they rate safety as a high priority).
c) **credit challenged users**: users with temporal bad debt problems due to loose of job or other reasons. They are usually not able to pay postpaid, and cause uncollected revenues to operators. Focus prepaid to this segment could be a way of avoid uncollected revenues.

Customer Segment and Profile to Fit to Product Strategy	Prepaid	Contracted	Hybrid/Blended
Consumer – Credit-Challenged, Behaviors Over Time	✓		
Consumer – Temporary Crisis, Lost Job	✓		✓
Youth Market	✓	✓	✓
Occasional User	✓	✓	
Business		✓	
Data Customers		✓	

Table: segmentation of customers according Teradata. Hybrid (combination of pre and post paid) can also be applied. [59]

Main characteristics that can influence in prepaid usage and growth:

a) Predefined (self imposed) credit limit
b) Customer can remain anonymous
c) Service is viewed as a commodity (e.g. Can be bought or sold as a present)
d) Flexibility: No contractual commitment to Service Provider and customer can change easier Service Provider.

3.9.5 Implementing M-commerce

M-commerce is a lucrative and growing market. According ARC group 57 million people worldwide spent USD 2.3 billion in 2002 and by 2007 it is estimated 546 million users a total of USD 39.3 billion. As the figure shows prepaid is the second most lucrative area after content downloading.

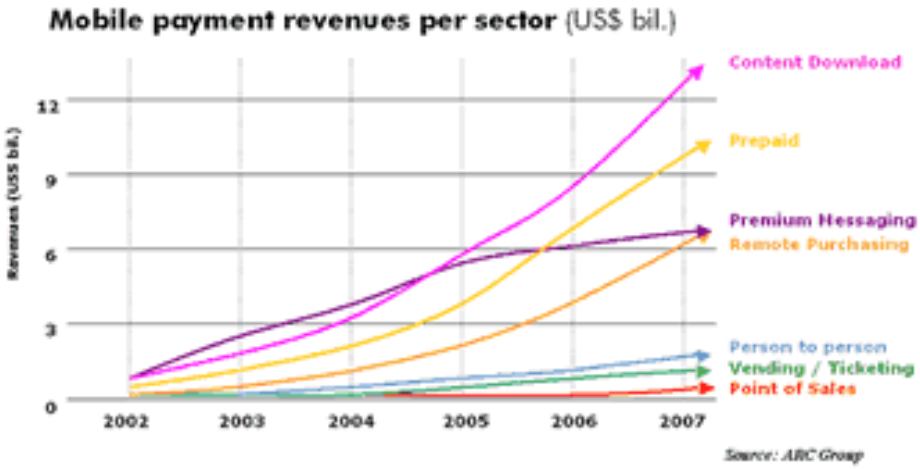


Figure 48: forecast of the mobile payment revenues per sector up to 2007 [62]

Examples of implementation of m-commerce through prepaid cards can be seen for example from Sweden, where "3" have launched "3Reload" service. For SEK 149 it is possible to buy this card, that it can be reload for SEK 100 (out of which SEK50 is for content services). Prices for this service are: SMS SEK1, MMS SEK 1.9 and data SEK 18/MB. In this 3Reload case, "3" is encouraging users to use more data services through a convenient prepaid card service.

3.9.6 Wallet v/s phone billing

The first step in Europe for an e-wallet service has been EMU (Europay-MasterCard-Visa) smart card, implemented with the purpose of fighting against frauds (especially high in the UK).
In France "Iti Achat" service has reached 140,000 users in 2001 (dual slot handsets provided by Motorola and Sagem) and was estimated to grow. The idea of a server wallet (separated from operator's prepaid wallet) can be deployed through SIM, which enables authentication and identification to access to a 3rd party system.
Phone billing for micro-payment seems also to work. AT&T's iPIN had in 2000 12,000 users with an average spent of USD 6/month. The problem of this is that C&B system to operators seems to be expensive (typically 20-50% of total phone call cost).
In Spain, Telefónica and BBVA bank have deployed "Movilpago" service, which offers both prepaid network wallet and post paid (against a bank account) options.
Also in North America, the Bank of Montreal (Canada) launched on May 1999 "Veev"- server wallet service in order to do balance enquiries and bill payments. This service was also available in the US by Bell Mobility and US's Harris Bank. The interesting thing in this service was that people used "Veev" at most in cars (41%), followed by on transit (18%), at home (10%) and at work (21%).
One problem in these services' deployment is that banks don't make a lot of money from payments (about 7% of revenues), and banks are not willing to invest a lot in this area. Also a prepaid system is not considered cost effective if there are no at least 500,000 customers. [63]

3.10 Digital Right Management (DRM)

Digital right management or super-distribution is in tight relation with Mobile P2P services.

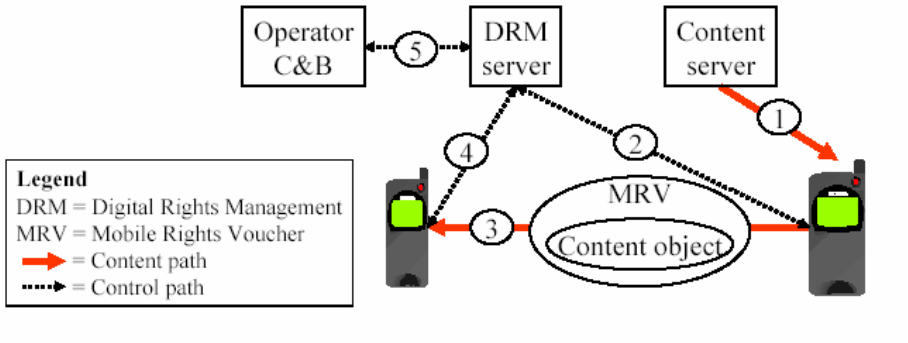


Figure 49: DRM in theory [48]

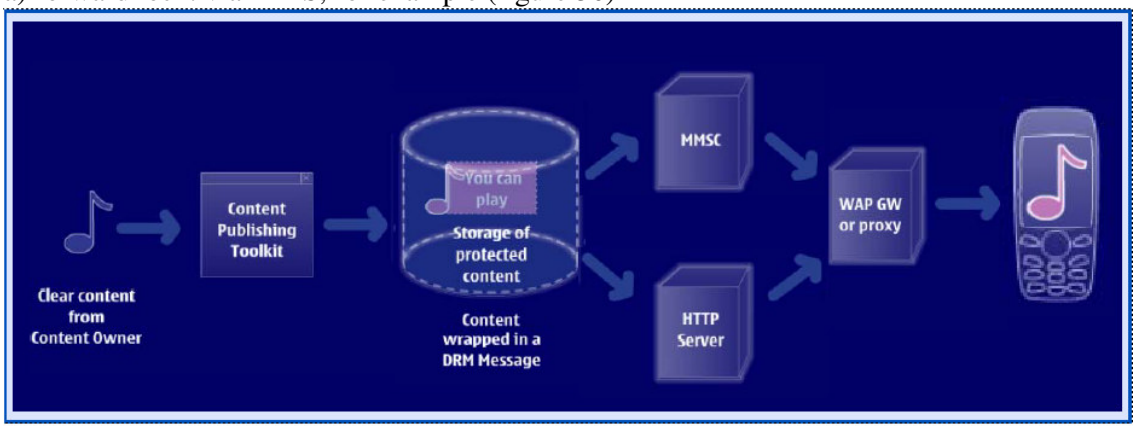
The idea is to deliver in a legal and massive way at the same time with low cost (for example through a MMS, or through a local way through for example infrared). Mobile operators can integrate DRM with existing charging system and charge to the end user when using the content (anyway cheaper to end user than getting by they own). With this piracy avoidance it is possible to get more revenues than before, giving to end users a cheap and legal way to get content.

Until the moment the most famous standard is the OMA-DRM from the Open Mobile Alliance, where Nokia, Panasonic, Real Networks, Samsung and Warner Bros Studios have set up the Content Management Administrator (CMLA) as a framework for the OMA DRM. There are already solutions that conform to OMA DRM spec. as for example BeepScience of Norway's Content Policy System (CPS) and End2End of Denmark's DRM solution.
Other initiative to facilitate super-distribution is The Content Reference Forum, which key members are Microsoft Corporation, Universal Music Group and VeriSign Inc. In this CR Forum there are some standard bodies working on it as MPEG, W3C, DOI, WS-I and OASIS.

3.10.1 OMA DRM architecture

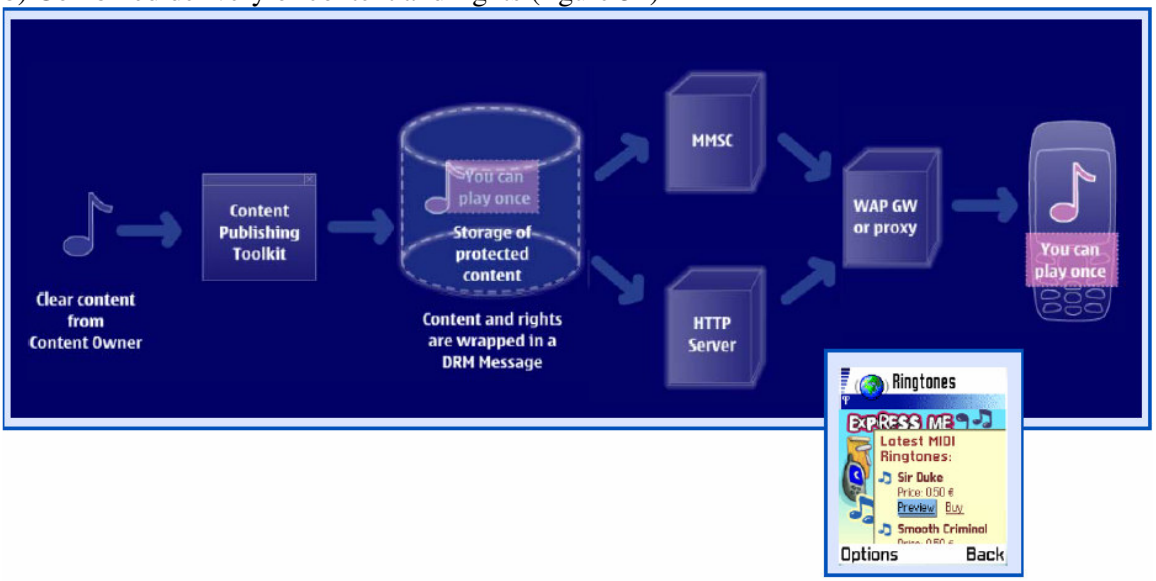
There are two releases on this standard. The first version (R1) is already in some models (Nokia's series x0, as the 6230, 6600 or the 7700). DRM R1 gives satisfactory protection for light content. The following version (R2) will provide good protection for premium content as music and video.
R1 is already because players wanted to accelerate the market. Anyway, this standard is focused on MMS and consists in 3 levels of communication: [64]

a) forward lock: via MMS, for example (figure 50)



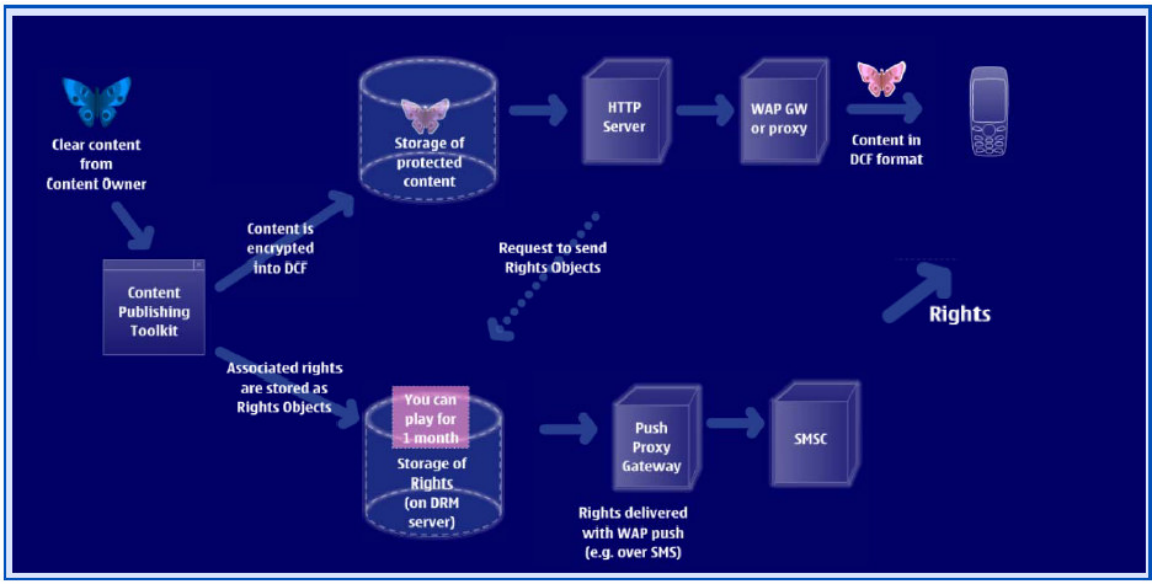
[64]

b) Combined delivery of content and rights (figure 51)



[64]

c) Separate delivery of content and rights (also called super-distribution). Figure 52.



[64]

From a general point of view it is needed for a super distribution two different storages: Content Storage, from which it is possible to download protected content (.dcf) and the Storage of rights, which push to terminal via WAP Push the rights object, after which content can be used as defined in rights object.
It is interesting to notice that the price depends on the way through which content is sent (MMS is more expensive than via locally).

3.10.2 CR solution

When the content is too big it is better to do a reference to its location rather than to send it completely. This is the case of a film, for example. This could solve somehow the problem of high tariff for double charging. [65]
Content Reference Forum's solution for bigger size content has the following actors:

a) **Content Reference** (CR): a XML data structure containing information about content description, distribution channel and consumer environment. It identifies a piece of content in the abstract.

b) **E- contract**: once CR arrieves to Reference Service, the appropriate response is generated based on the rules expressed by e-contracts (it describes relationship in the value chain).

c) **Reference Service**: RS takes data contained in CR, identifying relevant e-contracts and generating offers.

d) **Offer**: data structure that expresses how consumer can acquire particular instant of content (form of payment, for example). Has enough info, so that customer can make the decision.

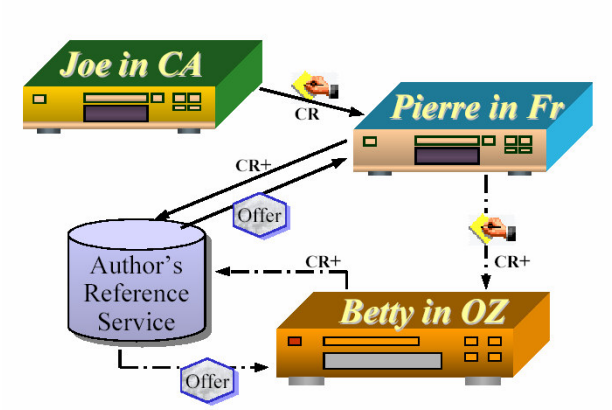


Figure 53: example of CRF: referring a video program to a friend. Joe sees a movie in Canada, and sends a reference about the location and data to his friend Pierre in France. Pierre receives the message and he decides whether to see the film through Canal+ Satellite for €4.95 or through amazone.fr on a region 2 DVD for €30. Again Pierre send a reference to Betty in Australia, and Betty receives possibilities of seeing it in her territory. [65]

3.10.3 Example of value system

As DRM is still under development, it is not so easy to explain how would be the value system. We are going to give here the example of BeepScience OMA DRM solution, which is extending its mobile DRM system to the Symbian O.S. Symbian ecosystem is used at the same time by smartphones as for example SonyEricsson P900, Siemens sX1 and Nokia 6600 (also Motorola and Samsung…). In Figure 54 it is shown a value system example with players as Sonera and Nokia.

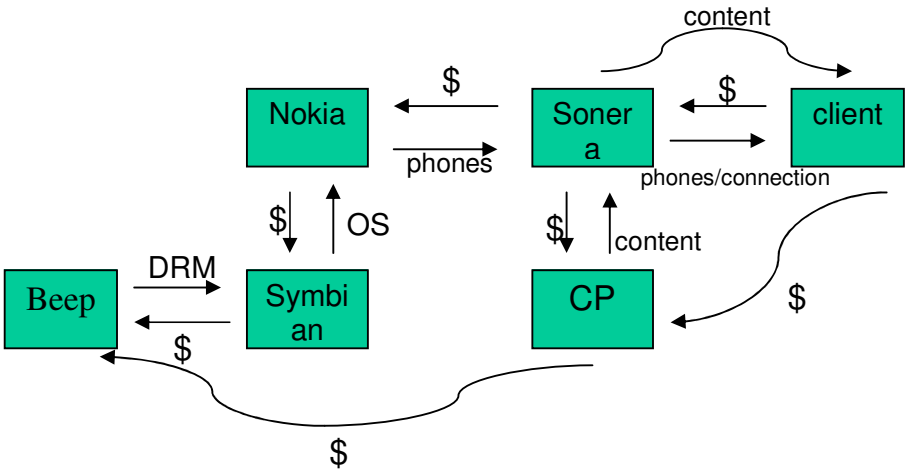


Figure 54: Example: DRM integrated to Symbian OS in Nokia handset, offered by Sonera (phone or/and connection). Content Provider (CP) offers content through operator's portal. Client can also pay to CP for content and to operator for the connection (double pricing) or only to operator (single pricing).

3.10.4 Value system

Anyway a more general value system can be represented by the following picture:

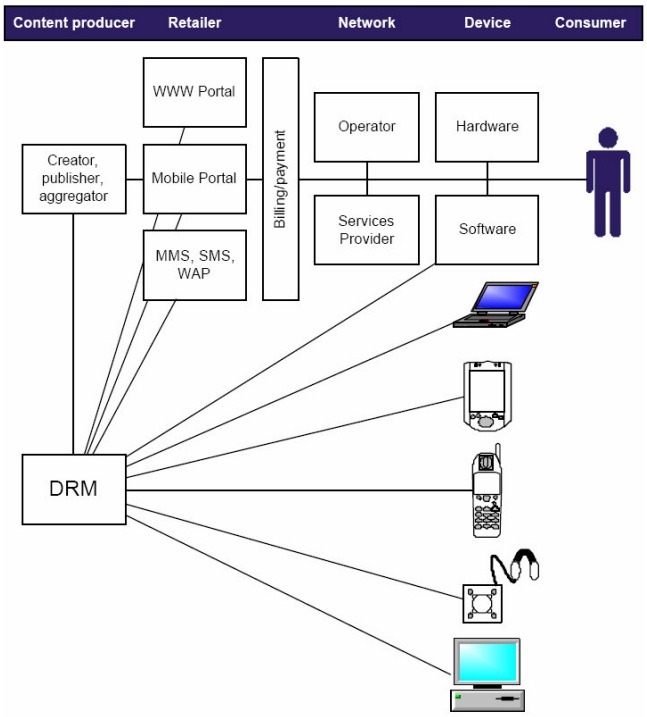


Figure 55: players involved with a DRM solution: content providers, retailers and device manufacturers. In Japan's case operators are the main player.[27]

a) Content providers

Already in the PC internet market content producers have deployed generic types of DRM solutions (username/password). As an example in the US we have Wall Street Journal Online and Sony Everquest. The main US's content providers are already working for a mobile solution. The big players in the US are: Universal, EMI, BMG, Warner and Sony (the "Big 5"). These companies control the 90% of sold music in the world (unit and revenue basis).

a) **Retailers: portals**

There are a large number of small players, none of them with extensive power. Some of them are operators' subsidiaries and they are making money through ring tones and logos (Ex: Kiwee from K-Mobile in France). They will also beneficiate from DRM.

b) **Mobile operators**

In Europe some of them are controlling portals. In Japan operators control everything; from retail to demand manufacturing. A good example of this is DoCoMo's i-mode. In Japan NTT DoCoMo and DDI Pocket are already using IBM's EMMS solution for their new services M-Stage and H (edge) allowing music download to phones.

c) Device Manufacturers

Nokia, Ericsson, Motorola and Siemens are already developing DRM solutions.

Nokia's OMA solution with IBM seems to be succeeding in the protocols' battle. Ericsson also is developing with Microsoft an OMA compatible solution.

3.10.5 Business model

The OMA's DRM standard is focused on MMS. For this reason is probable that first revenue models are pay download and subscription. Also with the time is possible to adopt models as pay-per-view, usage metering and super distribution.[27]
The actual existing paying model (Ex. Ring tone) is the following:

50%	Clearing house
20%	VAT tax
10%	Song writer
10%	Delivery cost (SMS)
10%	Ring tone's distributor and creator.

Also the first MMS content is expected to follow the same model. Due to double charging (for content and for traffic), content over mobile should be smaller than in fixed networks (Ex. 30 Kbytes instead of 3Mbytes).
At least in the first moment MMS could be the driver for DRM. The first and easiest way of using DRM is forward lock, which is a client centric case. With the time DRM could expand to super distribution (network centered solution) and P2P model.
Despite that technically we can't consider MMS as a P2P technique, we can say that MMS could be a driver for super distribution.
We have to consider also that consumer don't want to pay for content that it is available for free in the internet. They will pay only of content is easily available and its quality is high.
For this reason is better at the beginning to deploy a "good enough" DRM solution rather than a 100% secure DRM that could be too complicated for end users (people will reject it). [27]

In the following table there are some 2.5 G content fees. It is possible to see that double pricing is implemented in cases of bigger content as games, location services and Symbian applications.

Service	Content Fee	Transmission Fee
MMS	0,39 EUR/message	Free
Mono ringtones	0,95 EUR/tone	Free
Polyphonic ringtones	1,21 EUR/tone	Free
News	Free	Packet fees
Locator	0,66 EUR/search	Packet fees
Colour games	4,00 – 4,95 EUR /game	Packet fees
Symbian applications	0-20 EUR	Packet fees

(source: TeliaSonera)

3.11 Machine to machine (M-to-M) and Human to machine (H-to-M)

M2M describes communication (wired, wireless or hybrid) between machines and /or people. It can be referred as:

- machine-to-machine: wireless or hard-wired communication between two machines
- machine-to-mobile/man: monitoring of a machine by human user.
- mobile/man-to-machine: control of a machine by a human user

M2M is a wide area of services that is increasing in importance. According Harbor Research Group M2M market is going to exceed 100 million connections (wider concept than users) and USD 700 billions in revenues by 2010. Also according SK Telecom vision M-to-M is seen as a logical continuation for a future 4G with many applications

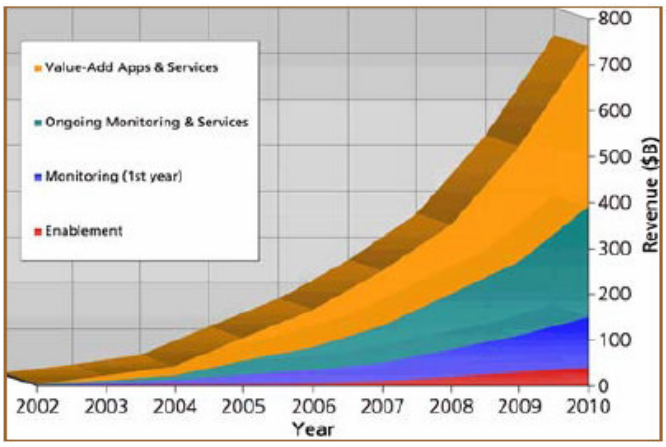


Figure 56: source: Harbor Research Group [66]

"With advances in technology, we are beginning to understand how monitoring remote assets can facilitate new revenues models, lead to dramatic cost reductions, and drive enhanced customers service initiatives" (Peggy Smedley, M2M Magazine) Devices can be "web- enabled" and accessible using standard Web browsing.

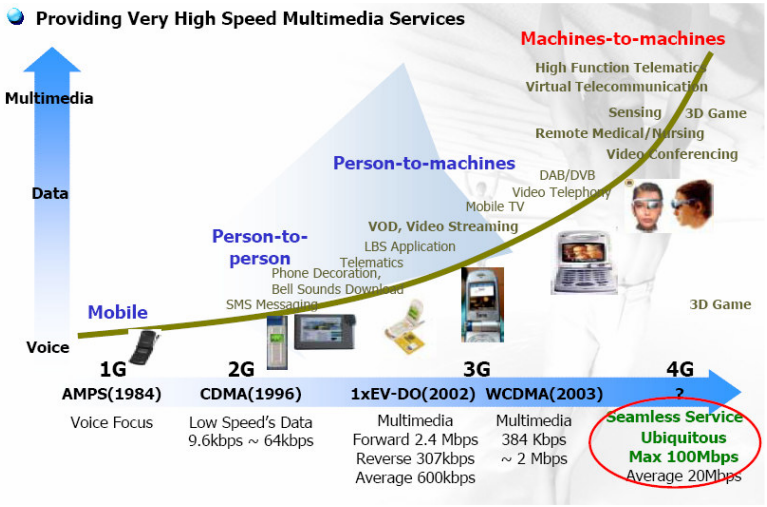


Figure 57: Future vision of services' development. [69]

In Figure 57 it is represented the future vision of Korea's SK Telecom, where M2M services are adopted into a 4G. In this 4G there is a high function telematics with even a 3D gaming included. For this purpose it is needed as always a bigger capacity.

3.11.1 M2M architecture

Generally there are 3 elements in every M2M networking:

a) intelligent device: where data originates (PLCs, I/O device, sensors, etc)
b) the gateway: translates and passes data to network
c) the network: serves data to remote clients

As networks it is used wired Ethernet, wireless, cellular or POTS.

There are 3 ways or strategies to implement M2M networking: [66]
a) **Push strategy**: the intelligent device gateway pushes data to remote device. Its implementation is not so expensive, because it is not needed always on connection.

Figure 58 [66]

b) **Pull strategy**: server pulls data from remote intelligent devices. Data is stored in database, from which can be broadcasted via network. This method is more reliable because enables 'to monitor the monitor', but it is more costly because need an always on connection.

Figure 59 [66]

c) **Push/Pull strategy**: combined push pull solution is recommended when it is needed to access intelligent device at any time and rely on the intelligent device to take action when an event is triggered.

Now we are going to see different example of M2M in leading countries.

3.11.2 Korea

The Ministry of Telecommunications (MIC) have decided that intelligent home networks should play a key role in the Government's overall ICT strategy and will target the industry with USD 213 million of investment from 2004 until 2007.
The Korean government hopes to have 10 million homes with intelligent networks by 2007 (61% of households in the country). [3]

a) Home network platform
The Government started a one-year test project to develop a home network platform based on Linux OS (to avoid licensing fees). Government will also establish an RFID research center. RFID chips can be used on food packaging to check which foods are out of the refrigerator via mobile phones. Also air conditioning in an apartment could be turned on and off. Problems in deployment are mainly in security issues and costs. Samsung and LG are already creating network-ready appliances. Samsung has interest in both areas household appliances and telecommunication handsets. Samsung is building a new apartment complex called "Tower Palace" to build and test these new services. Devices throughout the building are controllable via mobile phone. This includes air-conditioner, refrigerator, washer/dryer and electric gas stove.

b) SK Telecom is also offering to 'NATE' subscribers a service that allows leaving video messages when door-bell rings, and subscriber is not present. Video can be delivered to subscriber, and subscriber can open the door if he wants.

c) Key in phones
Door can memorize key-cards, mobile phones or any other devices with smart chip embedded on it. This system is more user-friendly as it is not needed to use hand for opening a door; just to shake the phone near the door is enough.

d) Mobile and cars
In this service it is integrated location based services into a car. For this purpose it is needed a mobile phone and a GPS (Global positioning system) in the car.
SKT's NATE subscribers can subscribe to GPS system. In this service user's position is given via GPS on their mobile phones with map and information about the area updated over CDMA network.

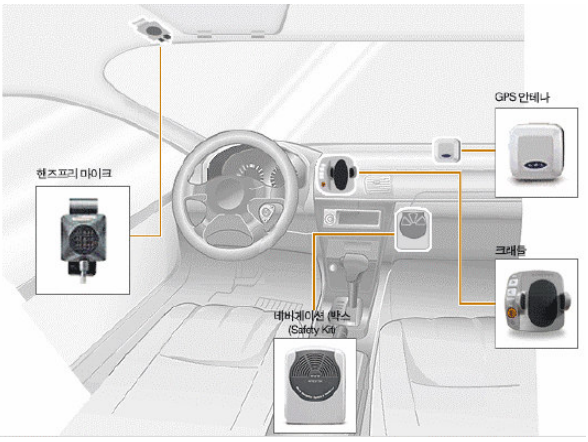


Figure 60: components from left to right: hands-free mike, mobile phone cradle, navigation box and GPS antenna (source: SKT www.drive.nate.com). [3]

3.11.3 Japan

In Japan there are some human-to-machine solutions in order to interact better with the mobile phone, and also some other classical M2M services. [2]

a) authentication of mobile phones with fingerprint sensor (DoCoMo's model F505i). In this phone it is possible to authenticate different menu's indexes with different fingers.

b) "Sonic Speaker" handset with Bone conduction technology, for people with problems of hearing the ring tone. This enables listening and talking "through bones", putting a finger on the ear and talking.

c) Navegation service in cars through internet.
"Air Navi" by Pioneer Corporation equipped with CDMA2000-1x provided by KDDI. This works with always-on connectivity, and provides all kind of information (hospital, train station, cinemas and restaurant) depending on the location of the car. Other example is Toyota's "G-Book" also through CDMA200-1x technology released in car model "Will Cypha". A surprisingly well adopted service is karaoke for customer not interested in location based services. From October 2003 Toyota increase the number of models of car with "G-Book" and expects gradually expand to all models. Barriers are still in cost of communication, data throughput, QoS and coverage.

d)VAIO media
Service promoted by Sony, which idea is to enhance the use of PC as video recorder. VAIO is a content sharing with home network service. It allows real time streaming of TV programmes via home networks. This enable to access contents at home's computer from outside.
[2]

3.11.4 USA

(Assumption)
In the US there are also some M2M ideas related specially with:

a) sensors to measure temperature, humidity, sunlight, etc and actuators operating heating, air-conditioning, humidifiers, opening/closing windows, etc.
b) integration with car, to develop a navigation system.
c) supply chain: track product more carefully to reduce stealing of products in stores. This could mean a huge cost reduction to retailers in some countries/areas.

In general there are a lot of ideas, but there is a problem with integration's adoption. Some services can make the life more difficult rather than easier, and sometime there is a human reluctance in adopting some kind of M2M services. [68]

3.11.5 Value System

M2M market implies new entrances in the ICT sector. Especially in the case of Home's equipment manufacturers, they are coming to ICT sector for their first time. It is not easy to describe with all kind of details the value system in M2M possible products, but from a general point of view there is the following relation:

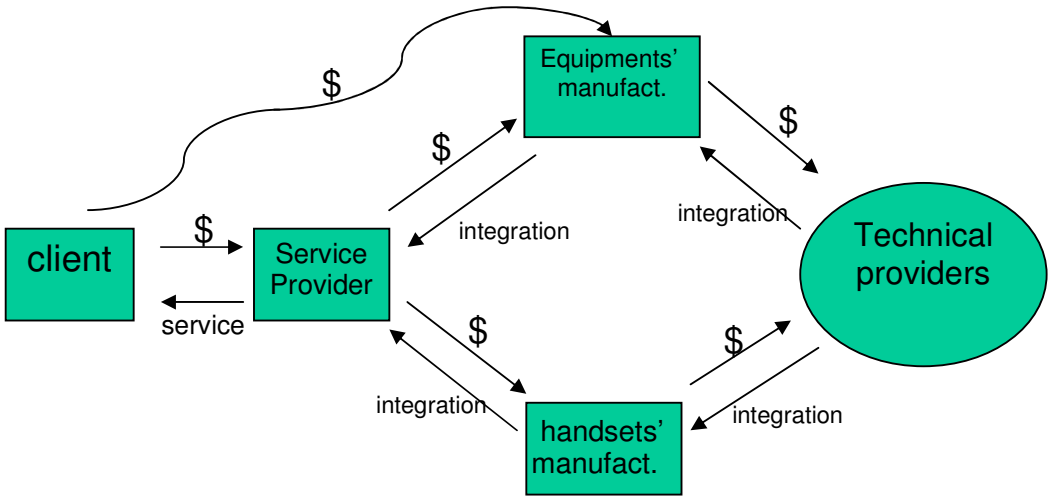


Figure 61: value system. House's equipment manufacturer can also be a car manufacturer or other kind of new entrance. Also end user pays to equipment's manufacturers directly, in the case that equipment is bigger (house, car, etc)

Also is important in this system the role of the handset's manufacturer. In the case of Korea and Japan manufacturers just provide handsets to operator, but in Europe and USA handsets' manufacturers have to deal separately with equipment manufacturers and operators. Anyway they have a similar relationship to operators than house's equipment manufacturers (integration/$).
From this point of view is interesting the case of Samsung, which can supply both handsets and house equipments.

In Figure 62 it is shown a different division from the point of view of roles within the value system. It is separated into 3: [67]
a) Companies that provide technology; devices enablement and system integration, enabling M2M services.
b) Companies providing devices (handset, electrodomestic), but with M2M features included (incorporators of M2M solutions).
c) Companies providing the whole service (service providers). Their role is to charge to end user and to provide maintenance and relationship with the customer. Usually there are old operators.
It is good to notice that this picture describe possible examples mainly from Europe and USA.

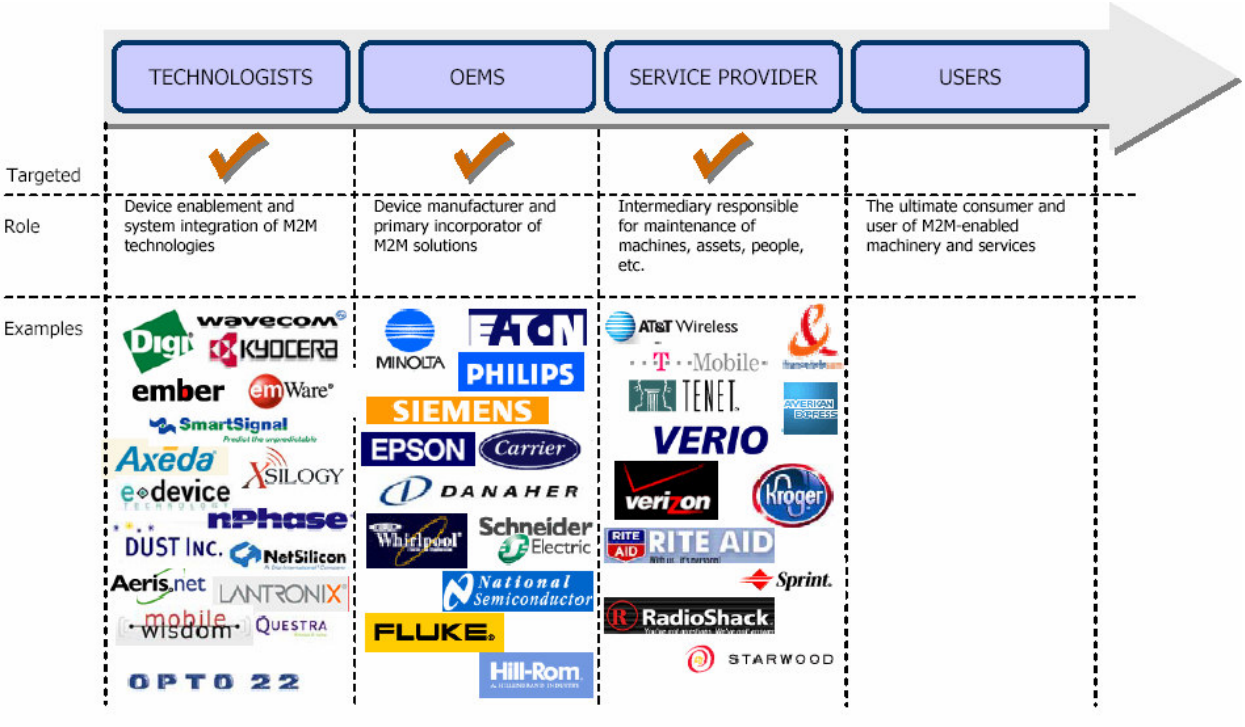


Fig 62: players in M2M, with different roles and companies' examples [67]

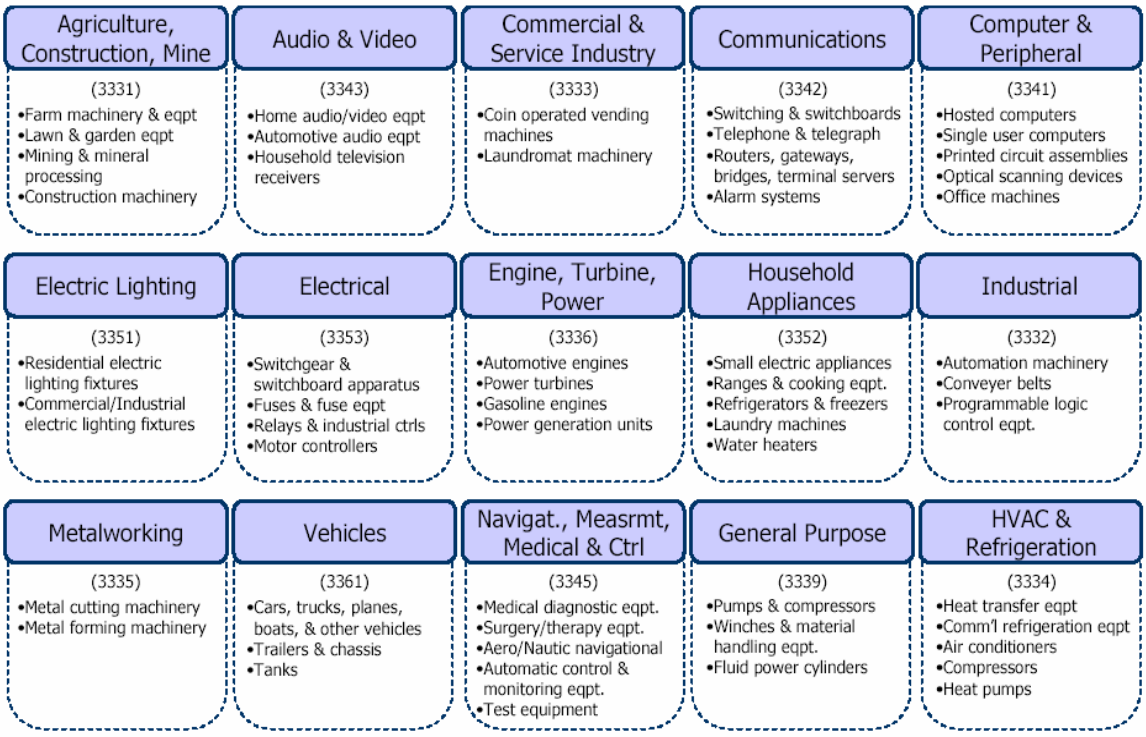


Figure 63: different areas in which M2M devices can be used. [67]

4- Service classification

Now that have seen all services in different leading markets, could be useful to do a classification according different patterns.

The first distinction that is possible to do is divide services according players involved:
-Services that involve new players in the industry
-Services that represent new opportunity of ARPU to old players, rather than involving new players.

It is good to notice in every service there are new players (new technology developers), but we try to mean here new players as the involvement of new industries into the ICT sector.
a) Services involving new industries

Service	**New industry involved**
M2M	Electro domestic, cars.
Browsing	Content providers
IP Data Cast	TV and radio channels
Mobile payment	Banks

b) Services representing new ARPU generation to old players.

Service	**Winners (who get revenues)**
PoC	Operator
Service Discovery	Operator, Content provider
P2P	Content provider, operator?
Mobile Email	Operator
Mobile VoIP	New operator
Prepaid data	Operator, Content Provider
DRM	Content provider, operator?

We can take into consideration here that MobileVoIP is an exception, because represent an opportunity to new players within the industry, and normally will go against old players' interests.

Conclusions

As a general conclusion we can see each service from the point of view of the Finnish market, and see what is the situation or what kind of services are likely to come.

Service	**In Finland**
Prepaid	Missing in Finland. Future m-commerce?
PoC	Nokia's role. Not sure how the usage will be.
Mobile Email	In business. For normal customer MMS is more important.
Mobile VoIP	No clear plans.
IP Data Cast	Finland is leading this service.
Browsing	WAP 2.0. Needed services as "Vodafone live!"
M-payment	e-wallet, next step.
M2M	Some ideas. Anyway not leading.
Service Discovery	Possible operators' role. Nokia developing Jini. Interoperability
DRM	Already in some Nokia phones. (OMA solution)
Mobile P2P	Double pricing to bigger contents.

According this table there are services that are missing, as prepaid for m-commerce (already existing in Japan). M2M implementation there is no too many as in for example Korea.
There are some other services, where especially Nokia has played an important role in its development as DRM, PoC or even Service Discovery. Also Nokia was planning to launch a GSM/Wi-Fi enabled phone but just as another feature.
In order to be a leading country nowadays it is needed to deploy all possible services. It is needed to see why missing services are not still available. Some reasons are cultural.
There are some services, in which is important an integration with other industries. In the case of M2M, it is logical to think that other bigger countries (USA, Japan or even Korea) have advantages related to little countries as Finland, because they have more players in other industries. Anyway could be possible an international cooperation.

References

[1] "A perspective on the mobile markets in Japan and Korea" Lawrence Cheung, Hong Kong productivity Council, 2003.
- ITU/MIC Workshop "Shaping the Future Mobile Information Society", Seoul, March 2004:
[2] The case of Japan
[3] The case of Korea
[4] Contextualizing the Mobile Internet, Master thesis, University of Amsterdam, Richard Tee, May 2003
[5] "Mobile data 2004", September 2003, European Wireless Telecommunication Services.
[6] "Telepalveluyritysten rakenne ja toimintamahdollisuudet" Viestintä ministeriö 2004
[7] www.3g.uk.com 3G worldwide news
[8] ITU 2001, "USA mobile competition"
[9] "Service Discovery in Wireless and Mobile Networks", University of Texas, 2003
[10] "Protocols for Service Discovery in Dynamic and Mobile Networks, University of Florida, USA, 2002
[11] "Service Discovery In Future Mobile Commerce" by Dipanjan Chakraborty and Harry Chen, 2000
[12] Classification of Service Discovery in Pervasive Computing Environments, Michigan State University, 2002
[13] i-mode pricing, Sandro Grech, HUT, April 2003
[14] www.mobileMMS.com, through [13]
[15] Mobile music white paper: "Content download client, a way to close the gap between mobile and media industry", www.northstream.se, February 2004.
[16] Northstream research
[17] Nokia's press release http://press.nokia.com/PR/200312/928228_5.html
[18] Nokia's press release http://press.nokia.com/PR/200403/938377_5.html
[19] Nokia's white paper "IP Datacasting", 2004
[20] "Satellite launch signals the arrival of TV on mobile", W2n, wireless web news, 7th June 2004
[21] IP Datacast Forum material http://www.ipdc-forum.org/about/resources.html
[22] DiBcom's homepage: http://www.dibcom.net/home_long.htm
[23] "Broadcasting Commercial Data on Mobile P2P Networks", Tommo Reti, Yki Kortesniemi and Mikko Välimäki, 2002, HUT
[24] "Peer to peer and SPAM in the Internet", chapter "Economics in P2P", Report based a Licentiate Seminar on Networking Technology Fall 2003, editor: Raimo Kantola., HUT
[25] IDC: Reasons for Using Napster, IDC #24454, April 2001, http://www.idc.com, accessed November 20, 2003
[26] Service adoption of PoC, Timo Ali-Vehmas, HUT, Spring 2004
[27] "The business case for Mobile DRM", Netlight Consulting AB, Stockholm Sept 2002
[28] Critical Path's solutions for different markets.

[29] Vodafone Blackberry http://www.vodafone.co.uk/cgi-bin/COUK/portal/ep/browse.do?channelPath=/Vodafone%20Portal/Business%20Services/Email%20anywhere/BlackBerry
[30] Nextel's homepage http://www.nextel.com/
[31] FierceWireless www.fiercewireless.com
[32] "Pricing of Mobile Messaging, 24.3.2003, Tapio Teppo, HUT
[33] "Spam, from nuisance to Internet infestation, P2P& Spam, HUT ("Peer to peer and SPAM in the Internet", Report based a Licentiate Seminar on Networking Technology Fall 2003, editor: Raimo Kantola., HUT)
[34] Telecom Forum course "Roaming WLAN" lecture, spring 2003
[35] Finding harmony between VoIP and WLANs, CommsDesign.com, Nov 2003
[36] Signalling protocols course, Spring 2004, HUT
[37] "Recent Communications policy developments", OECD Communications Outlook 2001
[38] Article: Article: "Leaving the phone company out of the loop" By Marcelo Rodriguez, Special to the Mercury News, http://www.mercurynews.com/mld/mercurynews/business/technology/personal_technology/6478054.htm)
[39] Yahoo! News 2004, Skype lunches Mobile VoIP
[40] Article: "Tokyo to get world's first IP mobiles", The Japan Times - 7 Oct 2003 http://www.japantimes.co.jp/cgi-bin/getarticle.pl5?nb20031007a1.htm
[41] Thefeature.com article "DoCoMo Wi-Fi Phone shows carriers' hand", 2004
[42] Korea's case study about IP telephony, ITU 2001
[43] From www.broadbandreports.com
[44] Ericsson's "PoC architecture", release 2.0, 06.2004
[45] PTT: Using Mediation to Integrate PTT Services, February 2004, www.acecomm.com
[46] From www.mobileIN.com
[47] MoCoBe.com survey, 2003
[48] Networking business course, Spring 2004, HUT
[49] Mobile Internet worldwide 2000
[50] From iblnews.com
[51] WAP and i-mode, HUT (Pauli Aho), March 2004
[52] Nokia's Next generation mobile browsing, white paper 2003
[53] Advatages of XHTML for wireless data, Nokia's white paper, 2001
[54] Forrester research
[55] Northstream Aug 2002, Mobile payments
[56] "Mobile payments in m-commerce; Telecom Media Networks, Cap Gemini Ernst & Young, Sept 2002
[57] World atlas of mobiles 2003
[58] ITU world telecom indicators database
[59] Data Warehousing for Prepaid products and services, Teradata, February 2004
[60] "Making digital mobile payments, infozech
[61] APOnline, August 2003
[62] www.alcatel.com/lead/mcommerce.html
[63] Emerging models for mobile commerce, Consult Hyperion white paper, May 2002
[64] Content protection with OMA DRM, Sami Viitanen, Dec 2003, Nokia Forum
[65] CRF-004 document, introduction, March 2003

[66] M2M Device Networking 'Components & Strategies', Marty Huff
[67] "M2M Adoption Forecast", the FocalPoint Group, 2003
[68] Machine-to-machine integration: the next big thing?, InformationWeek by Carl Zetie. April 2003,
http://www.informationweek.com/story/showArticle.jhtml?articleID=8900042
[69] SK Telecom
[70] World Telecommunication Development Report 2002, ITU March 2002.
[71] "Comparison of services discovery protocols and implementation of the service location protocol" Technical University of Munchen, Germany, 2001.
[72] "Emerging threats: P2P file sharing", Websense, 2003.
[73] Nokia's article "P2P technology for content distribution", 2004
http://www.nokia.com/nokia/0,,54018,00.html