Mobilizing Business Applications

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Mobilizing Business Applications

A survey about the opportunities and challenges of mobile business applications and services in Finland

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Preface

This work was funded by the National Technology Agency of Finland (Tekes). The work was carried out under the NETS – Networks of the Future Technology Programme. The work was started in September 2004 and finalized in December 2004. Interviews for the research were carried out between October and December 2004.

Mobile applications and services have been discussed extensively during recent years. Most of the discussion has been either over-hyped hail about new possibilities or complaints about the shortcomings of promises in developing the mobile service business. There has been a lack of analytical analysis of the realistic opportunities and challenges of mobile technology in business and people's everyday life.

This research attempts to create a realistic picture of the role of mobile technology in businesses. Furthermore, the research tries to identify the most burning challenges and attractive possibilities in development and employment of new mobile business applications.

The authors would like to thank all persons involved in creating this report. The persons interviewed deserve warm thanks for their valuable contribution. We would also like to thank Tekes for funding this timely research.

December 2004

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Contents

Acronyms

.NET	A set of software technologies for connecting information, people, systems, and devices made by Microsoft
3GPP	The 3rd Generation Partnership Project
ABC	Always Best Connected
API	Application Program Interface
ASP	Application Service Provider
BT	Bluetooth
C++	Object-oriented programming language
CRM	Customer Relationship Management
DRM	Digital Rights Management
DVB-H	Digital Video Broadcasting: Handhelds
ECMA	European Computer Manufacturers Association
EDGE	Enhanced Data rates for GSM Evolution
ERP	Enterprise Resource Planning
ETSI	European Telecommunications Standards Institute
FFA	Field Force Automation
GIS	Geographic Information System
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HD	Hard Drive
HR	Human Resources
HSCSD	High Speed Circuit Switched Data
HSDPA	High-Speed Downlink Packet Access
HTTP	Hypertext Transfer protocol
ICT	Information and Communication Technologies
IDE	Integrated Development Environment
IDE	Integrated Development Environment
IETF	The Internet Engineering Task Force
IMPS	Instant Messaging and Presence Service
IMS	Internet Messaging Services
IP	Internet Protocol
IPsec	IP Security Protocol
IR	Infra Red
ISO	International Organization for Standardization
ISP	Internet Service Provider
IT	Information Technology
J2EE	Java 2Enterprise Edition
J2ME	Java 2 Platform, Micro Edition
Java	Object-oriented programming language
JCP	Java Community Process
kB	kilobyte
LAN	Local Area Network
M2M	Machine-to-Machine Communication
MB	Megabyte
MIDP	Mobile Information Device Profile
MIS	Management Information Systems
MMS	Multimedia Message Service
NETS	Networks of the Future – a technology programme of Tekes
NFC	Near Field Communication
OGC	OpenGIS Consortium
OMA	Open Mobile Alliance
OS	Operating System
OSGi	Open Services Gateway Initiative
OTA	Over-The-Air
PC	Personal Computer
PDA	Personal Digital Assistant
PIM	Personal Information Management
PKI	Public Key Infrastructure
PLMN	Public Land Mobile Network
PoC	Push to Talk over Cellular
POP	Point of Presence
PWLAN	Public Wireless Local Area Network
QoS	Quality-of-Service
RAM	Random Access Memory
RFID	Radio Frequency Identification
ROI	Return of Investment
SCM	Supply Chain Management
SDK	Software Development Kit
SDR	Software Defined Radio

SDRAM	Synchronous Dynamic Random Access Memory
SFA	Sales Force Automation
SIP	Session Initiation Protocol
SLM	Service Lifecycle Management
SME	Small and Medium-Sized Enterprises
SMS	Short Message Service
SW	Software
SyncML	Synchronization Markup Language
Tekes	National Technology Agency of Finland
UI	User Interface
UMTS	Universal Mobile Telecommunication System
URI	Universal Resource Identification
USB	Universal Serial Bus
VPN	Virtual Private Network
W3C	The World Wide Web Consortium
WAP	Wireless Application Protocol
WCDMA	Wideband Code Division Multiple Access
WISP	Wireless Internet Service Provider
WLAN	Wireless Local Area Network
WMS	Web Map Service
WPA	Wireless Protected Access
WWW	World Wide Web
XML	Extensible Markup Language

1 Executive summary

This research deals with new mobile business applications and services in business use. The work was funded by Tekes.

The main questions for this research were: What is the current role of mobile solutions in business use? What are the major challenges to utilizing mobile technologies in business use? What are the most important (mobile) technologies in the short term and how will they evolve during 2005–2010? Where do the most promising new possibilities reside? These questions were approached by background research and interviews of persons involved in businesses developing or utilizing mobile services

Based on interviews and background analysis, the challenges for mobile services are mostly non-technical: the currently available technical enablers for creating new services are sufficient for most needs arising among the prospective users of mobile services. The real challenge lies in understanding the needs of the customer and whether a mobile solution responds to these requirements – mobility does not solve every problem. Introducing a mobility aspect to a business practice can change the processes related to the way the business is conducted and what the player's roles are in a new value network. In addition to changing current businesses, it will create new ones.

One of the main problems in the mobile application business is that there is no clear and shared understanding of the structures of value chains/networks for mobile services. Another challenge is the large number of different terminals and especially the incompatibility between terminal programming platforms. Understanding user needs is very important, but developer must also understand that ease of use and usability is really important for a successful mobile service. As the implications of deployment of mobile services in business processes are difficult to anticipate, the lifespan of mobile services and mobile terminals is very short, mature technologies and fast, iterative processes should be used for implementing mobile business services.

The main factor for pushing towards mobile business services is the need for connections to/from existing corporate IT systems to mobile terminals and an efficient way to use these applications outside the office. In general, mobile services are best suited to tasks with a need for real time information without requirements for large displays or input capabilities. Bandwidth is an important issue, but good coverage by the mobile network is even more important from the mobile business services point of view.

Promising new mobile services, such as mobile payments, rich call and group communications, are seen as the next major enablers for new businesses: these are already standardized and waiting to be launched.

2 Introduction

Mobile applications and services have been considered an important era of information and communications technology. The development of mobile network technologies as well as mobile terminals has offered users, developers and businesses new opportunities to access valuable information, communicate or be entertained regardless of time or the place where the person resides.

Person-to-person communication has been the main service for the end users of mobile terminals. In addition to voice communication and voice mail, new capabilities have been developed in mobile terminals and networks. Nowadays it is possibly for virtually anybody to access emails and a calendar when mobile; browse and message no matter where you are, take photos and videos and share them with one's family or friends.

The above-mentioned functionality is something that has been marketed by mobile phone manufacturers and operators. Advertising about new possibilities has mostly been targeted at consumer markets. However, there is increasing interest among business users to take advantage of the every time, everywhere, every device-concept in order to be more effective and productive and run the business better.

The main focus of this survey is mobile business services and applications. Part of these solutions have and will be implemented using same the technology and enablers as in consumer services. Therefore consumer viewpoint is included in this report to some extent in order to clarify different possibilities in development and deployment of mobile services. The motivation for this research arises from the platform of maturing mobile technology and the potential benefits it can provide for business users.

This research attempts to answer the following questions:

- What is the role of mobile solutions in business use currently?
- What are the major challenges to utilizing mobile technologies in business use?
- What are the most important technologies in the short and medium term and how will they evolve during 2005–2010?
- Where do the most promising new possibilities reside?

Background research and a number of interviews have been carried out in order to enlighten these questions.

2.1 Related work and sources of information

The most important related work and data sources concerning this research are presented in this section. The related work consists of technology reviews, white papers, articles and scientific publications. The related work and a short overview of the most important information sources have been described below.

Mobile Services Market in Finland in 2003[1] is a report published by the Ministry of Transport and Communications. The survey deals with mobile services provided in the mobile telecommunications networks. The survey analyzes the Finnish mobile service market between the years 2000 and 2005. Development of mobile phone penetration is examined by mobile phone technologies.

Roadmap for network technologies and services [2] has been produced in the context of the NETS – Technology programme of Tekes. The report analyzes the development of network technology and services in the time frame 2007–2012. A number of so-called critical paths of technology and services development have also been introduced. In addition to extensive analysis of established international ICT-roadmaps, a summary of expert contribution was also presented.

Emergence of Wireless Services – Business Actors and their Roles in Networked Component-based Development [3]. This thesis published in 2004 analyzes the roles of actors in mobile and wireless service markets. Even though the viewpoint is from software architectures, there is a useful analysis of the roles of stakeholders in mobile markets.

Whitepapers from various organizations, e.g. Nokia [4], SAP, Microsoft, Sun, HP, IBM, Vodaphone, OMA and TietoEnator.

EU-projects (AMI@work [5], Mosaic-network [6]). A set of high-profile European projects that concentrate on Ambient intelligence in the work environment.

Market research organizations, such as *Gartner or IDC*, have produced various reports regarding the telecommunication business as well as wireless and mobile applications markets [7]. The reports produced by these organizations are at best condensed, high-quality reports for foreseeing the near future of business.

2.2 Trends and drivers that make mobile technology interesting in business applications

There are a number of trends and drivers that makes mobile technologies an interesting component in business applications. There are a few fundamental megatrends behind these business trends that do have an impact on all businesses in society. The most important of these megatrends identified in [8] are

- *Global fight for investment* Countries and geographical areas fight for investments, which forces areas to improve competitiveness and attractiveness. Important factors in this fight are taxation, the innovation landscape and price of work.
- *Redistribution of work on a global scale* or a drift of routine work from western countries towards developing countries and markets, such as China or India.
- *Ageing of the population* forces businesses and public services to apply ICT and new technology to make service concepts more effective. This trend applies to the majority of rich industrial countries. Aging will have a major impact on various fields of life.

The megatrends presented above have been discussed extensively in various media during recent years. Public discussion seems to include relatively coherent views about megatrends and their implications for the development of society. The analysis of megatrends also yields quite similar success factors for the country or a company to service and succeed in the future.

Competitive and effective societies that have good economics and growth are in a good position in terms of the challenges set by these megatrends. The exploitation of information and communication technology has been considered one of the major tools for improving the productivity and competitiveness of societies and organisations.

Technology trends identified in [2]:

- *Information and communication technology markets are changing rapidly*. The implication of this development is that business roles and structures are constantly changing, thus opening up new possibilities as well as terminating outmoded businesses with low competitiveness.
- *Convergence of information and communication industry continues*. Convergence is taking place in many levels: Industry level, network level, application level and content level. The implication of convergence development is that communication and information processing will pervade all fields of everyday life.
- *The importance of interoperability will increase*. Increasing number of network-based services, networked information devices and the amount of available digital content will open up major opportunities for new businesses. In order to take full advantage of this, development standards and open software platforms are needed for developers to build services and applications. There are already a variety of very influential standardization bodies as well as industry forums to do this work.

Actions to be taken based on these trends in order to build a competitive society do have a strong flavor of policy making. This is not in the scope of this report. However, the factors driving businesses to apply mobile technology is in the focus of this research. The key drivers for a company to apply mobile technologies in businesses have been discussed in section 3.

2.3 Unexpected changes in the business environment

Predicting future technologies and business environment would be relatively easy if the nature of all development was evolutionary. However, this is not the case in the real world. There are disruptions in development of technologies, businesses and societies. The analysis in this report is based on the assumption that it is highly likely that revolutionary technologies that would make current approaches to mobile business services obsolete instantly will not happen within the timeframe of this research.

The prediction of disruptions in economics or societies is beyond the scope of this research. It may be good to keep in mind that there are lots of different issues or events that may have a major impact on the development of technology, business or societies. These occasions can be, for example, political decisions (e.g. UMTS-auctions in Europe), epidemic diseases (e.g. SARS), natural events (e.g. earthquakes) or terrorism etc. These unexpected rare events may be a disaster to many but a possibility for someone else.

2.4 Definitions

The purpose of this survey is firstly to analyze the mobile business from the viewpoint of potential users of mobile business applications. The second aim is to provide a general overview of the available technology for implementing mobile business applications. The third aim is to collect and analyze information from Finnish businesses concerning their needs and challenges regarding mobile business applications.

In order to set solid cornerstones for analyzing mobile business applications in this survey, a set of concepts and terms needs to be defined. The following definitions have been selected for use in the context of this study.

Business application refers to electronic services that have a high correspondence to the business processes of the company. Typical business applications are applications for

customer relationship management (CRM) or enterprise resource management (ERP).

Mobile business solution refers to a set of business-oriented applications that are operated using mobile terminals, such as mobile phones or PDAs. In a broader interpretation, laptop PC's with wireless connectivity can also be considered devices for mobile business solutions.

Mobile application stands for a computer program that is executed in a mobile computing platform such as a PDA or a mobile phone. The mobile application may include data storage, data processing or viewing or transmitting it to another application or server.

Mobile service is an electronic service that consists of three main components: a mobile application or mobile browsing as a client, wireless networking and server implementation providing the needed functionality or information (*Content*) to the user.

Service in this context refers to activity in which a person or an organization takes actions to provide something useful for another person or organization.

Mobile work is a combination of technology, workplace organization, work facilities and support systems allowing people to work mobile and in multiple locations at different times to suit their work processes and work-life balance needs [6].

2.4.1 Mobile workers – who are they?

The classification of mobile workers has been introduced by [9] in a Star-project [10]. In the [9] model, the main factors for classifying mobile workers are frequency of changing location and the number of locations where a worker carries out tasks. There are five categories in this classification: On-site movers, Pendulums, Yo-Yos, Nomads and Carriers. The categorizations of mobile work have been illustrated in Figure 1. These clusters have been described in more detail below.

On-site-movers move continuously inside a geographically limited area when working. For example, the working area can be a plant area or office premises. Examples of On-site workers are security and maintenance personnel. The frequency of location changes for on-site-movers varies from low to continuous.

Pendulum workers change location quite often. They have few possible working places. An example might be a person doing remote work. He may possibly have two or more regular working places – the office and home.

Yo-Yo's are workers that have many working locations inside a geographically limited area. For example, a salesman responsible for a district is an example of this kind of worker.

Nomads are those persons that work continuously wherever they are. A nomad is highly mobile and the area of mobility is not limited to a certain geographical area. An example of a nomad is a manager of a global organization travelling between office sites.

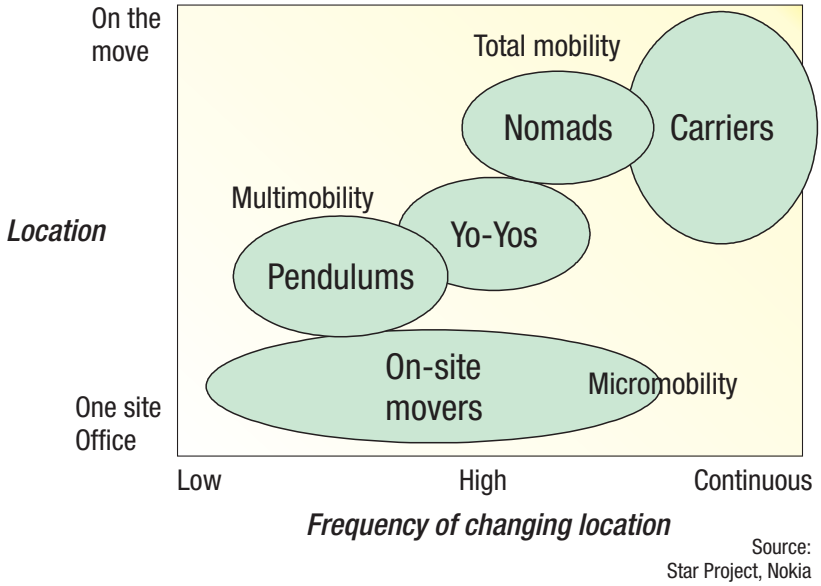

Figure 1. Categorization of mobile work scenarios

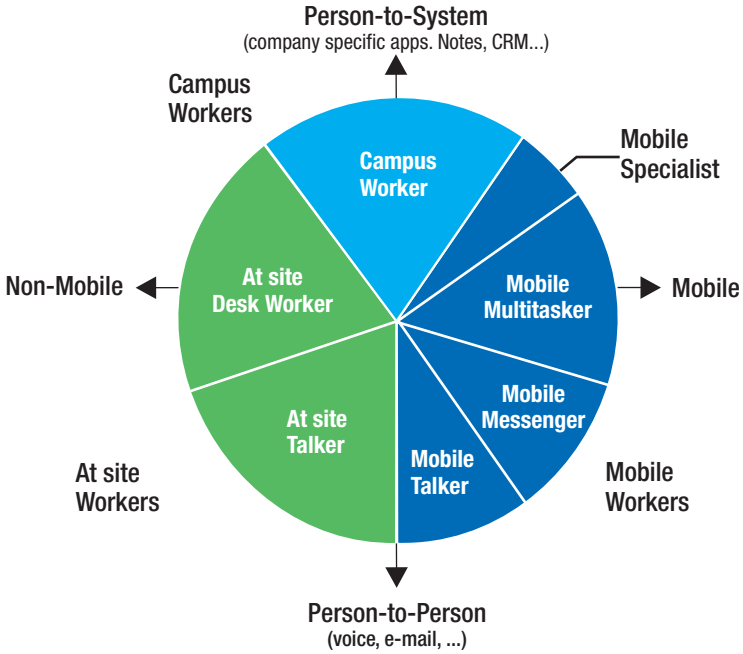

Figure 2. Employee service and mobility profiles [4]

A worker that is on the move all the time can be called a *carrier*. Carriers are even more mobile than nomads. This kind of worker might be e.g. a lorry-driver or a taxi driver.

Another classification of mobile workers has been presented by Nokia [4]. In this classification, the main dimensions of the analysis are the degree of mobility of a worker and the type of communication needs required for carrying out tasks. This model has been illustrated in Figure 2.

Mobile Workers are divided into four segments according to their use of different services. They are all highly mobile, but the Mobile Talkers' main device during the day is their mobile phone. These employees are often employed in coordination and sales functions. Mobile Messengers speak a lot on the phone, but in addition they often also communicate by sending text messages or e-mails to distribute information or confirm issues. Mobile Messengers could be, for example, truck drivers or sales team managers [4].

Mobile Multitaskers differ from Mobile Talkers and Messengers in the sense that they have a more frequent need for certain enterprise-specific applications such as CRM or warehouse database applications [4].

The main characteristic of Mobile Specialists main characteristic is that they often need to have a laptop connected to an enterprise Intranet or to a specific application. They also may have to send very large amounts of data while mobile [4].

Campus Workers are mainly white-collar employees in medium-sized or large corporations. They have a PC/laptop, a mobile phone and a fixed phone. Mainly working within the enterprise's premises, they also travel regularly between enterprise sites or to external domestic and international meetings. A distinctive characteristic of Campus Workers is their mobility and frequent use of a PC; they may work for many days at one site, mainly at a desk with a PC, but also have periods of intense travel[4].

At-site Workers spend most of their time on the enterprise premises, at the same work center, and are divided into two segments according to their use of PCs. At-site Desk Workers frequently use both a PC (e-mail, office applications etc.) and phone in their work and their mobility is low, one example being a call center service person or a research worker. At-site Talkers usually have only a fixed phone and they may not use a PC at all or may have a common PC for occasional use. They may also have a slightly higher mobility than At site Desk Workers – for example, salesmen in a hardware shop could be characterized as At-site Talkers [4].

The aim of the classification of mobile workers in this research is the need to understand the type of applications the worker uses in order to carry out his/her daily tasks. Another important issue is to understand what the best technologies to implement these applications are. Therefore, we have combined the main factors from two models introduced earlier in this section and produced a classification

that suits the needs of this research. Our model has three main factors that characterize the type of mobile applications:

- Type of communication needed (person-to-system/person-to-person)
- Degree of dependability of communication networks i.e. the location where the data resides (possibility to use the application off-line)
- Existing applications in terminals/browser-based solutions/specially tailored applications

It is also important to note that a company developing mobile solutions has alternative possibilities for implementing services; some enablers may have built-in-in devices available, some enablers can be bought and some parts the developers need to build themselves. When selecting the technology to be used, the degree of mobility of the user is an important factor as well as the required input/output, processing or communication capabilities.

2.5 Contents of this report

The remainder of this report has been structured as follows. Markets for mobile business services and applications have been discussed in section 3. An overview of mobile services and applications is given in section 4. Mobile technologies and their foreseen development are discussed in section 5. In section 6 a summary of interviews is provided and the issues raised are discussed. The summary has been divided in 5 subtopics: Markets/Business, Services, Terminals, Networks and other issues. The final section contains a discussion of the findings of the analysis and interviews.

3 Mobile business application markets

This section provides an overview of the markets for mobile business applications. Mobile business applications refer to the utilization of mobile communication and computing technology in order to carry out business-related activities.

The analysis consists of the following components:

- An overview of the markets for mobile services in Finland
- An analysis of the most important business drivers regarding mobile business applications
- An analysis of value creation models in mobile business services

The goal of this section is to provide the reader with an overview of the markets for mobile business applications in Finland. Business trends and the most important business activities in the field have also been identified.

3.1 Mobile services markets in Finland

The Ministry of Transport and Communication recently published a survey about mobile services markets in Finland 2003 [1]. The main focus of the survey is services that are targeted for consumers. Despite the focus on mobile services for consumers, the service also provides good background information for mobile business applications and services.

In [1], mobile services have been classified into the following categories: Private Communication, Content Services and Mobile Data Services.

Private Communication consists of private text-based messaging (e.g. Short Message Service), Multimedia messaging (MMS-messaging between private persons), email-messaging, instant messaging (e.g. Push-to-talk) and other forms of private messaging.

Content Services refers to text-based content services (usually implemented using SMS-technology), 2.5 content services (e.g. WAP and MMS services and downloadable applications) and other content services.

A data service refers to electronic a service that utilizes wireless communication technologies such as GSM-Data, HSCSD, GPRS, EDGE, UMTS and PWLAN.

According to Snellman [1], the value of the mobile services market in Finland in 2003 was 226 M€. The growth of the market was 14%. Figure 3 presents the development of the mobile services market in Finland. According to the figure, Private Communication is the dominant market share. However, the growth of that segment seems to have stopped. The growth in mobile business seems to reside in content services and data services. The main part of content services is the business of logos, ring tones and downloadable applications. According to predictions, the size of Content Services will be half of the price of private messaging by 2005. The size of the Data Services market was roughly 1/10 of that in 2003. It is likely that Data Services market will grow at a faster pace than the whole mobile services market

The diffusion of enhanced mobile terminals amongst private and business users is an important factor when considering the construction of business based on mobile services. The most important new features in the private users sector are Color display, GPRS/EDGE, WAP, MMS and Java Functionality. These enablers set the basis for the most current mobile services. According to data provided by eBird Scandinavia in [1], the number of these kinds of mobile phones will grow very rapidly in the near future (Figure 4). In 2004, virtually all new mobile phones in Finnish markets already have the above-mentioned features and by the end of 2005, almost half of all mobile phones in used in Finnish markets have these features.

Mobile services markets for consumers are tightly bound to the terminal base people use. However, the situation may be different in business use. Enterprises may also invest in more advanced technology (e.g. new terminals) if they can expect a reasonable return on investment. Figure 4 indicates the number of all advanced mobile phones in Finnish markets.

In the analysis above, only the value of data services provided by mobile operators has been discussed. An estimate or research on the value of mobile business applications market in Finland is much harder to obtain, because the total value of markets consists of many factors, of which telecommunication costs is only a portion. In order to provide a rough estimate of the potential of wireless data applications markets, an overview of the US markets is given in the section 3.2. The overview is based on Gartner's forecasts.

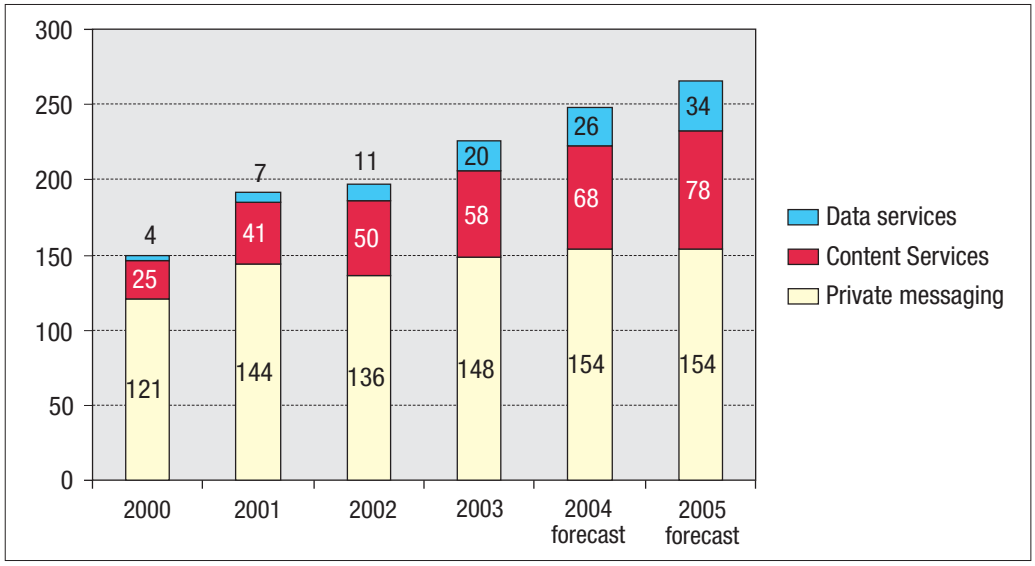

Figure 3. Mobile services markets in Finland 2002–2005 (M€) [1]

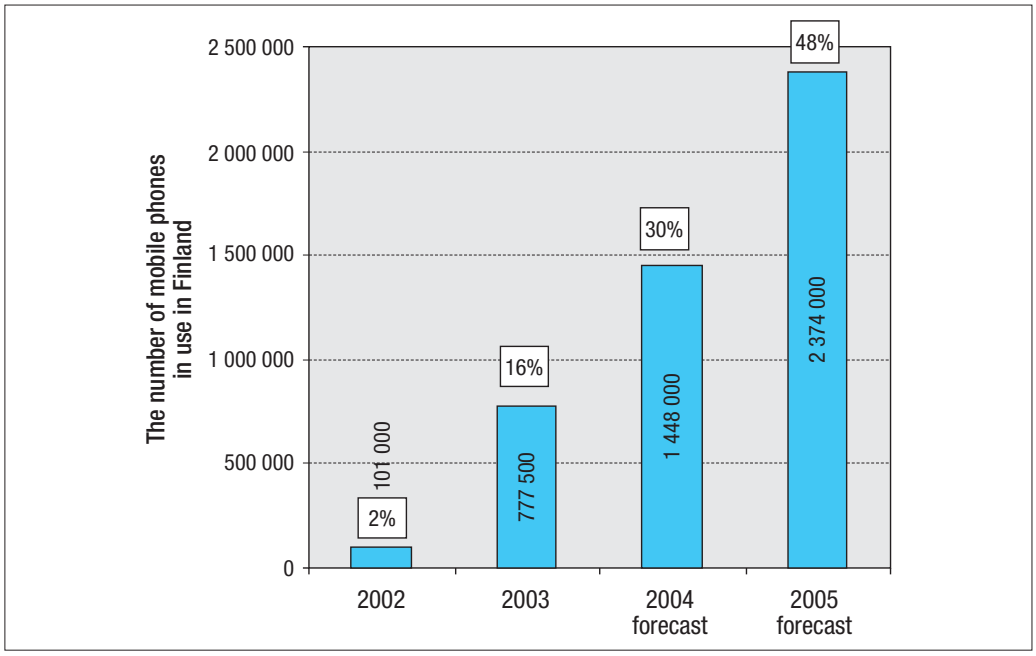

Figure 4. The number of mobile terminals designed with color displays, GPRS, WAP, MMS and Java in Finland 2002–2005 [1]

3.2 Mobile business services markets in the US

The number of users of mobile enterprise services has been predicted by Gartner quite recently. Figure 5 presents the estimated figures for users of wireless date services in North America during the time period of 2002–2008 [11]. According to the figure, the total number of users is estimated to be more than 50 million by 2008.

Figure 6 presents corresponding estimates about the size of market in dollars. Gartner foresees that the size of wireless enterprise application markets in North America in 2008 will be approximately 8 000 M$ [11].

3.3 Value creation in mobile business applications

Business models for mobile services have been discussed in [3]. The eight business models presented have been summarized in the following list:

- *Advertisement* where the service/website provide content and service mixed with advertising messages. Revenue is based on fees collected from advertisers
- In *Application provisioning*, applications, and sometimes platforms, have been provided for the customers. The revenue is collected from license and installation fees and maintenance services

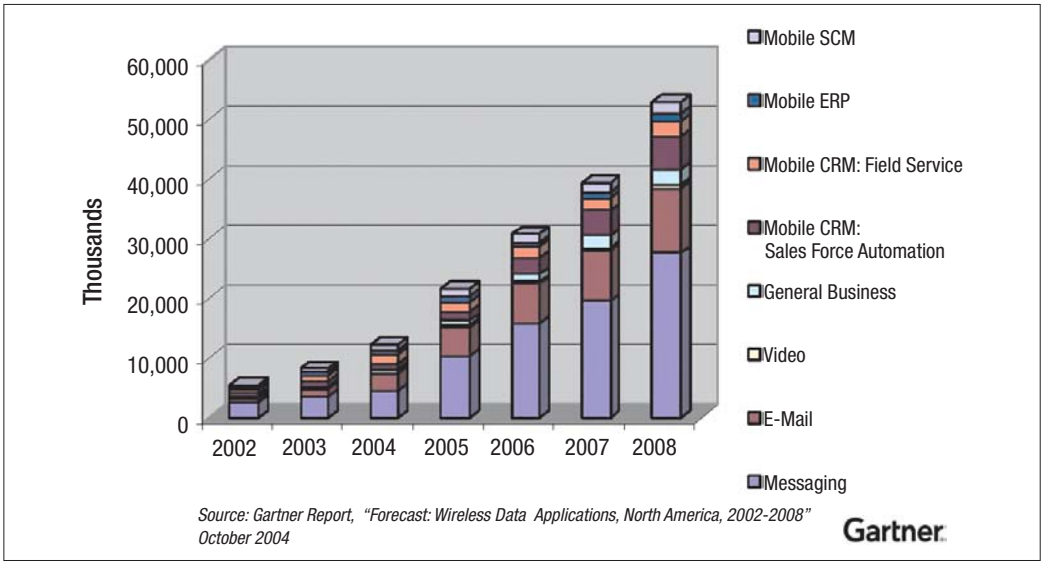

Figure 5. Estimate of the use of wireless data applications in North America, 2002–2008

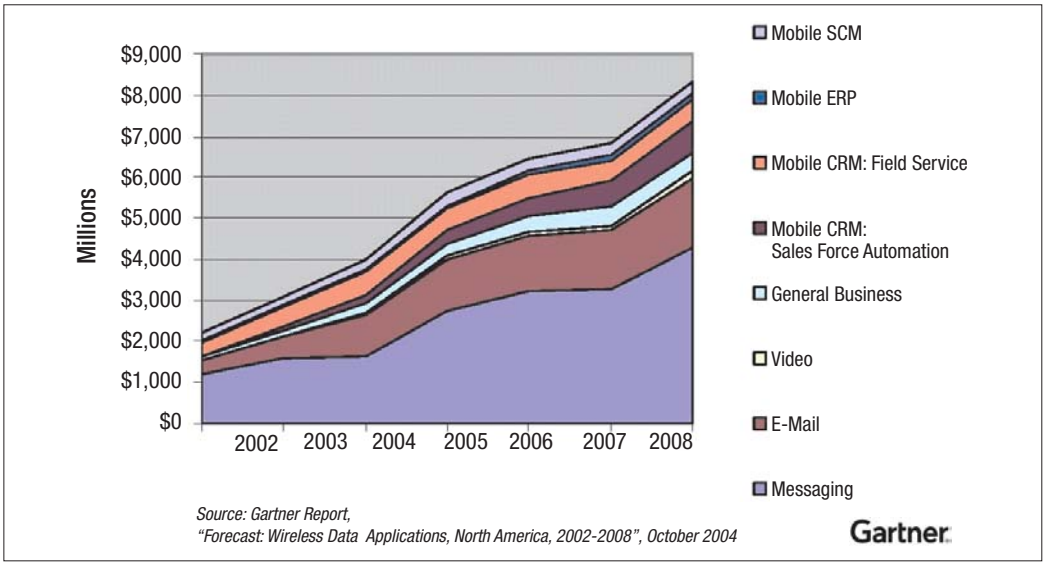

Figure 6. Estimate of the size of Wireless Data Applications markets in North America, 2002–2008

- The *Brokering*-type of business model is based on providing a common platform for stakeholders in the business network e.g. buyers and sellers. Revenue can be created from transaction fees.
- *Content provisioning* is based on provisioning and distributing content for customers and other services. Mobile content can be e.g. ring tones, music, logos, etc. Revenue is created from subscription and usage of fees.
- In *Infrastructure provisioning* applications, the network and system infrastructure needed to run the services has been provided. Revenue is created from fees for sale or leading the infrastructure.
- In a *Network operating* network, operators provide network services and capacity to other service providers such as ASP's, end users and ISP's. Revenue is created from the transmission, subscriptions and network services provided.
- The aim of *Service provisioning* is to provide end users with various network services. For example, Internet services provisioning provides hw and sw that enables users to access the Internet. Revenue is created from license and installation fees as well as subscriptions and traffic agreement fees.
- *Terminal manufacturing* produces and provides end users with physical terminals for a fee.

In [3], a number of roles in mobile business models have been identified. The most important roles are: Application Provider, Application Service Provider, Content Aggregator, Content Integrator, Content Provider, End User, Infrastructure Provider, Network Operator, Service Provider and Terminal Manufacturer.

Every business actor can function in the main business role in one or more business models, as well as play a participatory role in the business models of the other actors [3].

Business models and the roles introduced above provide an overall framework for considering value creation in mobile business applications. There are various factors affecting the real-world business models in different business sectors and markets. Perhaps the most important factors are the roles of players in the business network and operational environment (legislation, conventions, culture, etc) in the given markets.

In a very simplified model, value creation in mobile applications is based on increased revenue generation or cost reductions in business processes. In the consumer market, the main emphasis is obviously the former case. In business applications, cost reductions and process improvements seem to be the main drivers where mobile applications are concerned. Examples of this simplified model have been summarized below:

Cost reductions using mobile applications can be found via the following:

- Mobile office solutions improve communication and capabilities to access business data anytime. This improves the decision-making process and collaboration between teams.
- Improved efficiency of business processes due to real-time information updates to/from the corporate information systems. For example, acknowledgement of completed service tasks shortens process down time and delays in billing. (Mobile) access to corporate CRM and ERP systems anywhere/anytime is an important possibility for staff working outside the office to improve the quality and efficiency of the work.
- Radical changes in business processes enabled by mobile technology. Mobile technology enables various kinds of remote control or monitoring applications. For example, electricity meter readings can be automatized utilizing M2M-technology.
- Improvement of productivity and flexibility of business processes. There is evidence regarding dramatic improvement of productivity when applying mobility technologies[12].

Cost reduction and improved productivity is perhaps the main driver for value creation in mobile business applications. Another view is increased (direct and indirect) revenue generation through added-value services, improved customer satisfaction or differentiation from competitors etc. Examples of this kind of services are:

- Mobile services enabling a customer to monitor the status of service delivery, e.g. in logistics, (machine/car) service, etc.
- Added-value services for existing products. A mobile channel for customer feedback, information queries, advertisements, loyal customer channel, etc
- Mobile services as a complementary service in addition to the Internet/Intranet service. A limited set of (time/place-critical) web content also available via mobile e.g. travel information, bookings, schedules, mobile banking, watchdog services (e.g. used cars, apartments), etc
- The use of modern mobile solutions in order to differentiate in highly competitive markets. The basis for mobile investments can also be a more up-to-date corporate image in addition to cost reduction and process improvements.

Examples of potential point of process improvements and cost reductions as well as possible additional service provisioning in various businesses have been elaborated upon more in section 4.

4 Mobile applications and services

The following discussion starts with general remarks, looks first at vertical or business-sector-specific and core corporate applications, then at horizontal or native, commonly available mobile applications.

In the first section, we will discuss what common features business applications and services have. The discussion starts from the use of mobile business services in various business sectors. Five sectors were selected for analysis: healthcare and wellness, service businesses, industrial services, housing and building, and the forest industry.

In the following section, business-sector-specific enterprise applications are discussed. The application grouping is based on conclusions from interviews, public surveys of various business sectors, conference presentations, and information on the websites of international forums and system manufacturers. These business-sector-specific enterprise applications have been classified into eight categories: Common Corporate Applications, Mobile Shopping, Transport, Housing, Security, Travelling, Healthcare and Public Services.

The framework used in this research for discussion about mobile business services has been presented in Figure 7. In the figure ellipses represent examples of suitability of applications in specific business sectors

In the next section, core corporate business applications are summarized and examples are discussed. These corporate services are always system-to-system types. These applications enable the connection and use of corporate management and planning systems that handle resources, supply chains, customers, sales or field force activities.

The following section gives an overview of general-purpose (horizontal) mobile applications, which are used by various companies without any change to the actual software. The most common ones are often called mobile office applications. Other common horizontal applications are listed in the appendix.

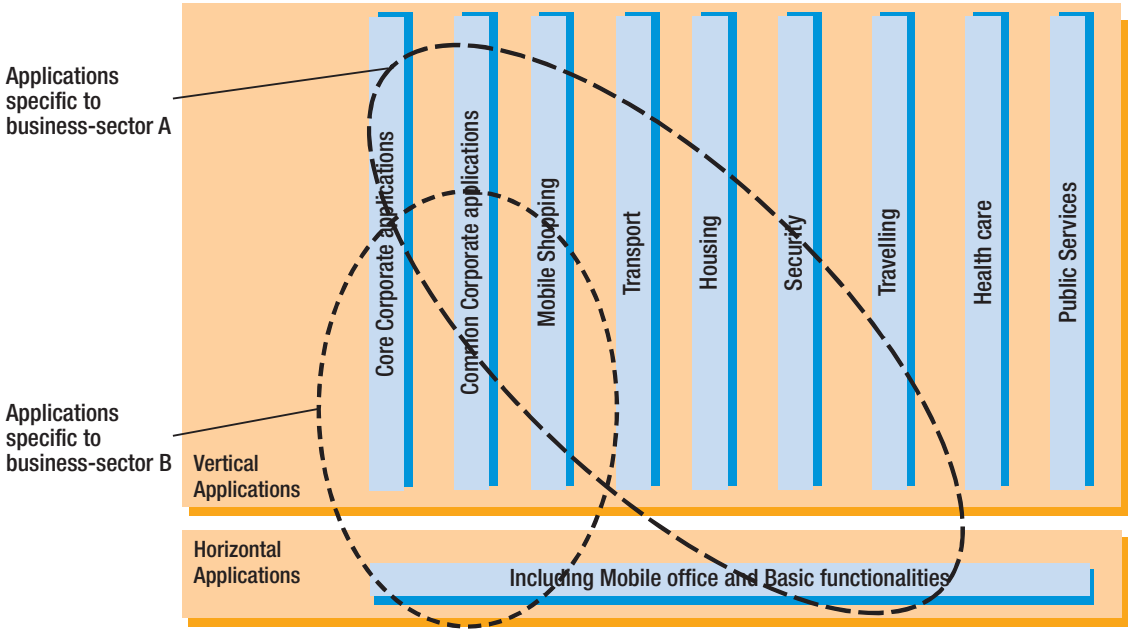

Figure 7. Framework for discussion about mobile services

4.1 Types of business applications and services

Most of the employees need a number of IT or communication services during their working day. These services can be categorized by the type of service. Commonly used services that are used in various business areas are called horizontal services, e.g. voice call, fax or email. Business sector-specific services are called vertical services, which are company-specific and tailored services. Another way of categorizing is based on the way communication is done, either person-to-person (voice call or SMS) or person-to-system (access to Intranet or calendar synchronization).

The business applications used are mostly horizontal services that are based on the customer's content but run on native applications existing on the mobile terminals and implemented by the terminal manufacturers. A little richer application type is based on native application, but has added functionalities, e.g. form overlays used to collect information from the user, but still use native applications as the basis.

More sophisticated company-specific solutions are based on common software platforms with widely used operating systems like Symbian or Windows CE, or further developed application platforms like Nokia Series60. Customer-specific terminal solutions are made for particular application areas or difficult operating conditions.

Mobile services are used through applications on mobile terminals. In many cases, the functionality or information that forms the actual content of the service exists in the server and is accessed via a client application or browser. However, there are situations when the content needs to be distributed or is totally needed in the terminal device. A general picture of the value chain of service provisioning is given in Figure 8. As discussed earlier, the necessary content is located in various parts of the chain depending on the implementation type.

The challenges in information services are the efficiency and reliability of methods and processes used in information gathering, management and distribution. Information gathering requires tools and equipment for data input with applications for data recording, information booking and storing. Information has to be gathered in the correct format, with the necessary accuracy and all the needed details.

Information management has to deal with data formats and protocols, database structures, information transfer, access rights and restrictions. In particular, the many existing specifications of mobile data formats and protocols allow a lot of varying implementations, which may make the appropriate selection difficult.

The information distribution of company-specific solutions can be based on existing communication systems. The main drivers are the costs, both investments and operational costs. In commercial service provision, the set-up differs in the sense that the variety of user terminals and available communications channels allows more possibilities, but also more challenges. Multichannel distribution is one of the opportunities through the availability of a wider user community, but also one of the threats because it creates bigger investment costs and the need for wider support for many communication channels (Figure 9).

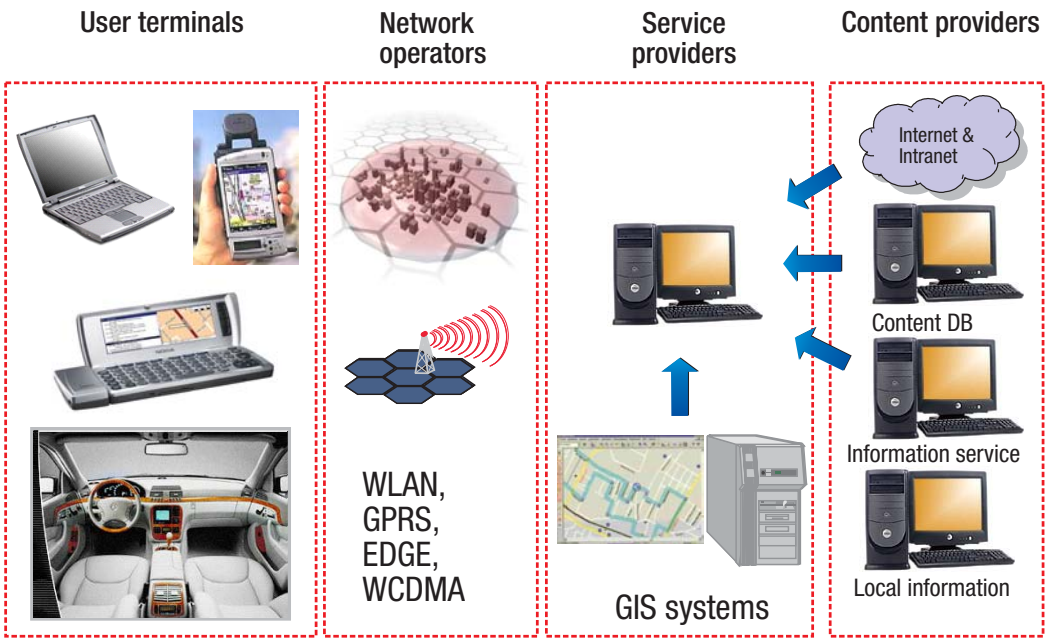

Figure 8. Value Chain of Mobile Services

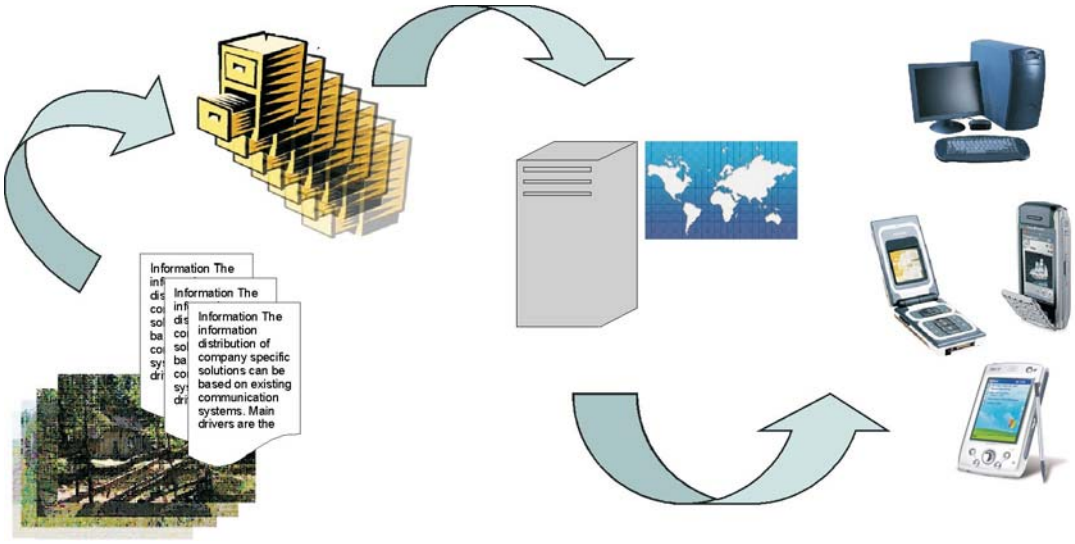

Figure 9. Information flow in Mobile Information Services

4.2 Interesting application fields

One objective of this research was to analyze the use of mobile services in business in various fields. Following business sectors were selected for more extensive analysis:

- Healthcare and wellness
- Service businesses
- Industrial services
- Housing and building
- Forest Industry

The basis for the selection of these business sectors was the analysis of Finnish key clusters [13]. According to the analysis, the sectors introduced above are the most important cluster in terms of size (current impact) or growth (potential) of the cluster. The ICT cluster is also one of the key clusters. However, the ICT domain was not explicitly analyzed in our research as it is implicitly interwoven in the focus of the research – utilization of mobile ICT is the key in building mobile business applications.

4.2.1 Healthcare and wellness

There are various possibilities for mobile services in the health care and wellness sector. There is a trend that aging will increase the number of home care personnel. Home care personnel could benefit from different types of mobile services. Voice communication is a self-explanatory application when staff is on the move. Other possible applications would be reporting of actions/operations taken when visiting the customer's home, a mobile system for supervision of work – guidance and control, mobile systems for increasing the security of persons working alone and making visits in homes.

Remote expert work is another interesting application in healthcare. Remote expert work might incorporate doctors and other specialists in care processes to contribute to the cure process without being present physically. These kinds of services could provide a partial solution for a lack of specialists in sparsely populated areas. General practitioners would possibly be able to carry out examinations of customers in health centers and a specialist could provide an expert opinion based on the results of examinations delivered to him/her using mobile technology. There are challenges in these kind of systems e.g. in security, change of current processes and capabilities and usability of terminals. There are already some pilot projects implemented and designed for evaluating these kinds of systems.

The wellness sector is expected to become an important business domain. However, business models and value chains in the wellness domain are currently forming. According to many articles and experts, there is considerable business potential in wellness-related products and services. There are already some pilot services available in this application category, but perhaps the most exiting services and business are yet to be seen.

4.2.2 Service businesses

Shopping can benefit from mobile services in many ways. Searching for the nearest shopping mall or nearest dealer for a certain trademark gives the user access to yellow page type of services enhanced with exact location information and possibly a special offer for desired goods. Finding locations in a mall can be made easy with local area network positioning and active guidance. An electronic shopping list helps to guide the customer to the correct areas of the

shop, or in the easiest solution, the shopping list can be used to order goods to the home. Mobile services can also be used to assist either the shopkeeper or the stockman in their everyday ordering or stock accounting activities.

Parcel delivery to the home or the arrival of a postal delivery can be announced with mobile messages. The existing systems are capable of following the parcel along its route from the sender to the receiver. This information could be enhanced with additional sensor data from the surrounding circumstances like temperature or acceleration for items that are either sensitive to temperature changes or fragile.

The banking business is searching for possibilities to serve their clients in the mobile mode. Methods for secure payment are being developed. Micro payment or electronic purse methods could make it possible to get rid of all the coins or at least minimize their use. One of the challenges to the banking business is how to maintain their existing status of trusted party in commercial activities; both credit card companies and insurance companies are trying to take over this role. In entertainment-related activities, copyright owners of music and music videos, and the big entertainment companies are similarly fighting for their right to act as the trusted party for DRM rights.

Both material and person transport will benefit from services that are able to provide exact arrival times and periods of transport. Logistic solutions can be further developed based on information from the delivery chains of goods. Automatic detection systems are making the cargo clearance and checking more efficient and less time consuming.

Securing buildings and people can be made easier with authentication and recognition systems, which are done on persons who are trying to enter guarded buildings. Remote surveillance systems support manual control of movement in guarded areas.

The tourism area needs a common way for tourists moving around their travel destinations to access relevant information. Activities exist for defining common interface protocols for information databases. Some large databases exist, but wider use of tourist information is still limited by proprietary databases and their limited access. General information can be accessed via public systems, but specific information is often rare.

Public transportation could benefit largely from the publishing of accurate time schedules and locations of public transport stops. In many cases, the timetable information exists and can be accessed quite easily, but the information on stop locations is far more difficult to get.

Public services could be the killer services due to the number of users and amount of usage, but normally these services are seen as services required by the authorities for free. These services have earlier been earlier provided free of charge (e.g. weather forecasts in TV) or they are expected to be free (e.g. traffic information), without consideration to the amount of effort needed for collecting that information or making the interpretation from the raw data.

Mail order selling services provide the users with most benefits through their mobile devices. Ordering of goods is simplified in that the available goods are shown for ordering in catalogues and the confirmation of ordering is simplified into a couple of steps that are needed for checking the ordered goods, credit card and delivery address.

4.2.3 Industrial services

Industrial services and services produced by the machine engineering industry are growing. Operations are outsourced and the life cycle management of products generates needs for new ways of operating and business opportunities. At first glance, only the operations change. However, in the long term, the change in operations will evidently also have an effect on skills, processes, knowledge management, field force support and even on the mechanical design of the product. Field force (people working in the field) is the critical point of contact between a service company and its customer. Mobile technology can help ensure that the service organization is able to serve the customers to their satisfaction. Furthermore, mobile capabilities can help companies grow revenue through better and more timely information about customer needs.

Field service technicians and other mobile personnel have to fill in a lot of standard paper forms when visiting the customer side. Reports are often prepared afterwards based on written or memorized data. This affects information flow in the organization, causing time delays and data loss that results in inappropriate decisions and customer concerns. Data collected in paper form should be then entered into the corporate database. This requires spending the valuable time of professionals or hiring additional staff to complete this task. Mobile staff efficiency might suffer from inconvenient ways of retrieving data from corporate networks and sending orders and reports back to the central office. Errors might result from retyping information from a paper into a computer.

Field force automation enabled by mobile technology provides an enormous opportunity for savings in operational costs and improving customer satisfaction rate. Wireless devices enable workers on the front line to access information in the back office: filling in standard forms and reports using mobile devices; workflow/order processing: sending requests to the office from mobile devices and checking status; storage of critical data on a mobile device; informa-

tion synchronization with corporate software; wireless data transfer, etc.

A big challenge in industrial services is how to apply mobile technology in a profitable way and make the service business look familiar to the staff that has engineering background. The service approach can be engineered towards the engineering world. Service engineering will produce tools, methods and solutions based on a well-established engineering heritage, even though the application industrial services like remote monitoring and maintenance.

4.2.4 Housing and building

This area seemed quite promising at the beginning, but it did not really turn out to be such. The construction business is mainly controlled by big construction companies, who do want to use their own proprietary systems rather than commonly defined systems and interfaces. Subcontractors are either forced to use their systems or be left out of contracts. Subcontractors, mainly of the SME type, would be more willing to use open systems, but they do not have the power to force the big players to use these systems.

Building maintenance information is an area that is gaining interest due to the interest in maintenance history and safety guidance requirements. Some companies have developed systems for real estate information systems, but they are mainly small companies, like the software company Passeli, and Buildercom.fi, a web-based information system for builders.

4.2.5 Forest industry

There are various potential points of utilization for mobile technology in the forest industry. A remarkable part of business processes in the forest industry have been carried out in remote areas. There is also a need for IT systems to make the management of global production and distribution processes possible and effective.

There are various processes in the forest industry where mobile ICT have an important role in managing business processes: harvesting, transport, logistics and maintenance are the most important. The origin of the wood is an important legal and environmental issue, therefore, systems that trace the origin of the wood are increasingly important [14]. Positioning is a versatile enabler and very useful in harvesting, transporting and logistics. In networked just-in-time-production where business processes have been integrated with suppliers and customers there is a need to have full control of processes all the time. This is a challenging task in harvesting and transport of the wood. Maintenance is also a challenge in the forest industry, since paper mills and the transport fleet are located in remote areas.

Even if the coverage of mobile networks is relatively good in populated areas and along main roads, this may not be the case in the areas where the wood is harvested. With regard to mobile applications in harvesting, special consideration needs to be given to reliable and cost-effective communication capabilities for mobile applications.

4.3 Vertical applications

Vertical applications are applications that are not common to all users of mobile devices, but instead are somehow business sector-oriented or corporate-specific. These services have been identified based on interviews, analysis of surveys done on various business sectors, information from conference and company presentations, the websites of forums and companies. The grouping of services is made by the authors and tends only to clarify the idea of similarities between some services in various business sectors. The suitability of services to the particular business sectors is expressed by a rough scale of Xs. A more detailed view of the suitability of particular services would require surveys of different business sectors.

4.3.1 Business sector-specific enterprise applications

Business sector-specific enterprise applications are discussed in this section. These applications have been classified into eight categories: Common corporate applications, Mobile Shopping, Transport, Housing, Security, Tourism, Health care and Public Services.

The rows in the tables in the following chapters (4.3.1.1 – 4.3.1.8) carry the names of identified services, which have been grouped based on conclusions from the interviews, surveys of various business sectors, conference presentations, and information on the websites of international forums and system manufacturers.

In following tables (Table 1 – Table 9) the columns express the followings: second column – type of service (person-to-person/person-to-system), third column – terminal application (native, original applications installed by the manufacturer/browser, application made on browser/specific, specially made application for particular use), fourth column – location of the content (in server, all content in infrastructure server/in terminal, all content in user terminal/distributed, content partly in terminal, partly in server), fifth to ninth columns – business sectors. The number of Xs in the cells refers to the suitability of the service to the particular business sector; three Xs for a well-suited case and no Xs for a not so suitable case.

4.3.1.1 Common corporate applications

These corporate services are always person-to-system or even system-to-system types. They are specific applications in the sense that they are not delivered among the basic functionalities in mobile devices, but are downloaded to the devices after the delivery from the original factory. These applications were selected for this group due to their wider nature e.g. they could be used by numerous companies.

The service for job lists for employees is very important in all areas where work is done in shifts and especially when shifts are changed. Job distribution and reporting is critical for jobs where either the target of the work is changing, built further or critical for life. The service business attaches high importance to customer feedback, activity management and sales reporting. The group of services related to industry automation systems is wide and is not dealt with in this report due to its non-mobile nature.

4.3.1.2 Mobile shopping

Mobile shopping can be seen more as an enabler for these business sectors, i.e. these services are used when necessary, but do not have any wider relevance for business. A service for activating appliances can have some importance in remote control and surveillance solutions for an industry environment. Identity verification is needed when a person's access rights are checked for authentication, authorization and accounting.

4.3.1.3 Transport

The transport sector has important services related to either person or material transport. Both types of services benefit from scheduled activities, a sufficiently accurate location information and tracking system for vehicles, goods or persons. Material loading/unloading as well as cargo clearance and checking systems are critical to efficient freight transportation.

Table 1. Common corporate applications

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/ Browser/ Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Service business	Industrial services	Housing and building	Forest industry
Job lists, rosters for employees	S	S	D	XXX	XX	XXX	XXX	XXX
Feedback information of employees	S	S	D	XX	XX	XX	XX	XX
Job distribution and reporting	S	S	D	XXX	XX	XX	XXX	XX
Info channel for loyal customers	S	S	D	X	XXX		XXX	
Management and reporting of activities	S	S	D	X	XXX	X	XX	X
Reporting from sales force	S	S	D		XXX	XX	XX	XX
Mobile device for stockman	S	S	D		X	XX	XX	XX
Mobile alert for person on duty	S	S	D	XX	X	XX	XX	XX
Maintenance service	S	S	D	X		XX	X	XX
Spare parts service	S	S	D	XX	X	XX	XX	XX
Industry automation system	S	S	D			XXX	XXX	XXX

Table 2. Mobile shopping

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/ Browser/Specific app	Content in Server / Terminal/Distributed	Healthcare and wellness	Service business	Industrial services	Housing and building	Forest industry
Money transfer	S	S	S		XX			
Micro payments	S	N	D	X	X			
Account status	S	S	S	X	X	X	X	X
Classified	S	S	S		X			
Auctions	S	S	D		X			
Shopping	S	S	D	X	X	X	X	X
Tickets	S	S	D	X	X	X	X	X
Activating appliances	S	S	D	X	X	XX	XX	XX
Paying at vending machines	S	S	D	X	X	X	X	X
Identity verification	S	S	D	XX	XX	X	X	X

Table 3. Transport

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/ Browser/ Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Service business	Industrial services	Housing and building	Forest industry
Material transport	S	S	D	X	XX	XX	XXX	XXX
Person transport	S	S	D	XX	XX	X	XX	X
Material loading	S	S	D	X		XX	XXX	XX
Target positioning, route guidance and receipting	S	S	D	X	X	X	X	X
Cargo clearance system	S	S	D			XX	XX	XX
Cargo checking system	S	S	D	X		X	X	X

4.3.1.4 Housing

Housing and building services are clearly the key service area for the building maintenance and construction business. Information about the history of the building and its maintenance is important to the users of the building. The importance of alarm systems and control of the building automation increases if critical information can be delivered to the mobile devices of maintenance personnel and the user.

4.3.1.5 Security

Security-service of buildings and construction sites can benefit very much from mobile communication possibilities. Healthcare and service businesses gain a great advantage from mobile communication.

4.3.1.6 Tourism

Tourism services are beneficial to all people, but increased advantages can be seen in areas where frequent traveling forms a significant part of work. Some of these services are such that they are not really asked for, but once tried, their usefulness is obvious and they are frequently used after that (e.g. rescheduling cases, delayed arrivals with public transport, late changes in itinerary).

On-time deliveries of orders, parcels and newspapers are not really noticed, but the delays, misdeliveries and short deliveries are noticed much easier. Services related to shopping and delivery of goods are quite critical in the sense that all the elements of selection, on-time and proper delivery and reception of goods at the user's facilities are present.

Table 4. Housing and building

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/ Browser/ Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Service business	Industrial services	Housing and building	Forest industry
Real estate portal for residents	S	S	S				XX	
Mobile access to real estate portal	S	S	D				XX	
Real estate portal for maintenance	S	S	S		X	X	XXX	X
Service history systems for real estates	S	S	S				XX	
Service history systems for residents and maintenance	S	S	S		X	X	XX	X
Real estate business with map services	S	S	S				X	
Auction of real estate	S	S	S				XX	
Automatic alarming of building maintenance	S	S	D	X	XX	XX	XXX	XX
Building automation system		S	D	X	XX	XX	XXX	XX

Table 5. Security

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/ Browser/Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Service business	Industrial services	Housing and building	Forest industry
Mobile communication for guards	P/S	S	D	XX	XX	X	XXX	X
Mobile communication for facilities under guard	S	S	D	XX	XX	X	XXX	X

Table 6. Tourism

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/ Browser/Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Service business	Industrial services	Housing and building	Forest industry
Booking system for hotels	S	S	S		X			
Price info for flights, hotels, car rentals etc.	S	B	D		XX			
Service for time schedules	S	B/S	D	X	XXX	X	X	X
Reservation and payment of travel tickets	S	N/B	D		XX			
Location-based service for schedules, route information and route guidance	S	B/S	D		XX			
Flight price file	S	B	D	X	X	X	X	X
Travel watch service	S	S	S	X	XX	X	X	X
Display for schedules on stops	S	S	S		X			
Real time head-way display	S	S	S		X			

4.3.1.7 Healthcare

Mobile communication as a means to ensure quick first aid as well as the possibility to get advice for one's own first aid actions is one of the best benefits of mobile services. Data communication is aided by a recommendation from the EU commission (July 2003) requiring positioning of all the cellular emergency calls in order to make the guidance of emergency personnel as accurate as possible. Services for laboratory appointments and results would decrease line-ups and simplify activities. Internal systems in hospitals as well as distributed healthcare systems are critical due to the intimate nature of delivered information and the existing threat to the life of patients in critical condition.

Table 7. Healthcare

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/ Browser/Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Service business	Industrial services	Housing and building	Forest industry
Mobile data communication for first aid	S	S	D	XXX	XX	XX	XX	XX
Home care service (e.g. for diabetics)	S	S	D	XX	X	X	X	X
System for laboratory appointments	S	S	S	XXX	X	X	X	X
Communication system for laboratory results	S	S	D	XXX				
Wireless systems in hospitals	P/S	N/S	D	XX				
Mobile aid for visiting nurse and home aid	P/S	N/S	D	X				
Distributed healthcare support system	S	S	D	XX	X	X	X	X

4.3.1.8 Public services

Public services could be the killer services due to the number of users and amount of usage, but normally these services are seen as services required by the authorities free of charge. Some of the services could be developed further and could become real mass-market services, but this may require privatization of some public functions.

Table 8. Public services

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/ Browser/ Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Service business	Industrial services	Housing and building	Forest industry
Reactivation of application	S	S	D	X	X	X	X	X
Communal eldentification	S	S	D	X	X			
Voting of organizations and municipalities	S	S	S	X	X	X	X	X
Reporting of offences	S	S	S	X	X			
Local information delivery system in public buildings and spaces	S	S	S	X	X		XX	

4.3.2 Core corporate applications

ERP, Enterprise Resource Planning, is a system that attempts to integrate all departments and functions across a company onto a single computer system that can serve all the particular needs of those different departments. ERP gets rid of all the old stand-alone computer systems in finance, HR, manufacturing and the warehouse, and replaces them with a single, unified software program divided into software modules that roughly approximate the old stand-alone systems.

Supply Chain Management (SCM) is the combination of activities that goes into improving the way a company finds the raw components it needs to make a product or service, manufactures that product or service and delivers it to customers. It is normally divided into five subtasks: Plan (how to meet customer demand for your product or service), Source (choose the suppliers who deliver the goods and services you need to create your product or service), Develop (a set of pricing, delivery and payment processes with suppliers and creation of metrics for monitoring and improving the relationships), Make (schedule the activities for production, testing, packaging and preparation for delivery), Deliver (logistics) and Return (create a network for receiving defective and excess products and supporting customers who have problems with delivered products).

Customer Relationship Management (CRM) is a business approach that integrates People, Processes and Technology to maximize the relations of an organization with all types of customers. The true value of CRM is to transform strategy, operational processes and business functions in order to retain customers and increase customer loyalty and profitability (definition by Aris Pantazopoulos – Founder, CRM Today).

Field Force Automation (FFA) replaces traditional paper and telephone-based systems with mobile and wireless solutions that enable access to key information directly from the field. Empowering remote workers with access to corporate data and applications, from any device, at any time, ensures better productivity and customer service. Activities covered by this term are in sales (SFA), relationships management (CRM), Service Lifecycle Management (SLM), equipment service, inspections and transport and logistics. Empowering Field Workers with Enterprise Information – Anywhere, Anytime.

Table 9. Core corporate applications

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app / Browser/ Specific app	Content in Server / Terminal / Distributed	Healthcare and wellness	Service business	Industrial services	Housing and building	Forest industry
Enterprise Resource Planning (ERP)	S	S	D	XX	XXX	XX	XXX	XX
Supply Chain Management (SCM)	S	S	D	XX	XX	XXX	XXX	XXX
Customer Relationship Management (CRM)	S	S	D	X	XXX	X	X	X
Field Force Automation (FFA)	S	S	D			XXX	XXX	XXX
Sales Force Automation (SFA)	S	S	D		XXX	XX	XX	XX
Back office connection	S	S	D	X	XXX	X	X	X
Customer specific applications	S	S	D	XX	XX	X	XX	X

Sales Force Automation (SFA) is a technique of using software to automate the business tasks of sales, including order processing, contact management, information sharing, inventory monitoring and control, order tracking, customer management, sales forecast analysis and employee performance evaluation. SFA is often used interchangeably with CRM; however, CRM does not necessarily imply automation of sales tasks.

4.4 Horizontal applications

There are many applications that are used by various companies without any changes to the actual software or the set-up of how applications are used. The most common ones are often called mobile office applications. There is a list of services that are common to many corporate users in the Appendix A. Later in this chapter you can find some of the key applications or technology enablers that are relevant to most cases.

4.4.1 Mobile office/Mobile work place

A mobile worker needs a number of applications, which are the same as either the personal applications or various corporate applications. The difference compared to personal applications is in the content and, in many cases, the way applications access content. In most cases, personal applications are used with an access to a mobile operator's access point and application server, while company solutions are based on more closed solutions with their secured VPN connections and servers protected with firewall structures.

Basic mobile office applications include email, calendar, corporate address book, fax and browser for accessing the Intranet/Internet system. Specific common corporate applications are related to secure accessing of corporate information systems, e.g. securing the transmission channel, checking the access rights and correctness of the transmitted information. Technical enablers for these include VPN, authentication, PKI and RSA SecurID solutions.

One of the key application areas in corporate solutions is information management, collecting, searching and storage. Various types of databases, directory services and search engines are needed. A vital part of this area with mobile workers is the need for synchronization of information between the mobile work force and the corporate information system. The synchronized information ranges from calendar and contact data to corporate-specific data in the form of totally integrated end-to-end solutions based on e.g. Lotus Notes, MS Exchange or the SAP system (often called groupware solutions or back office connections).

PIM or personal information management is capable of handling all the necessary mobile information. PIM applications help you organize your mail, addresses, to-do lists, appointments, and so on. PIM applications can be used both for corporate use and personally. There is usually a direct way from PIM applications to the use of a mobile phone or PDA, e.g. you can make a direct call by pointing your contact information in the address list.

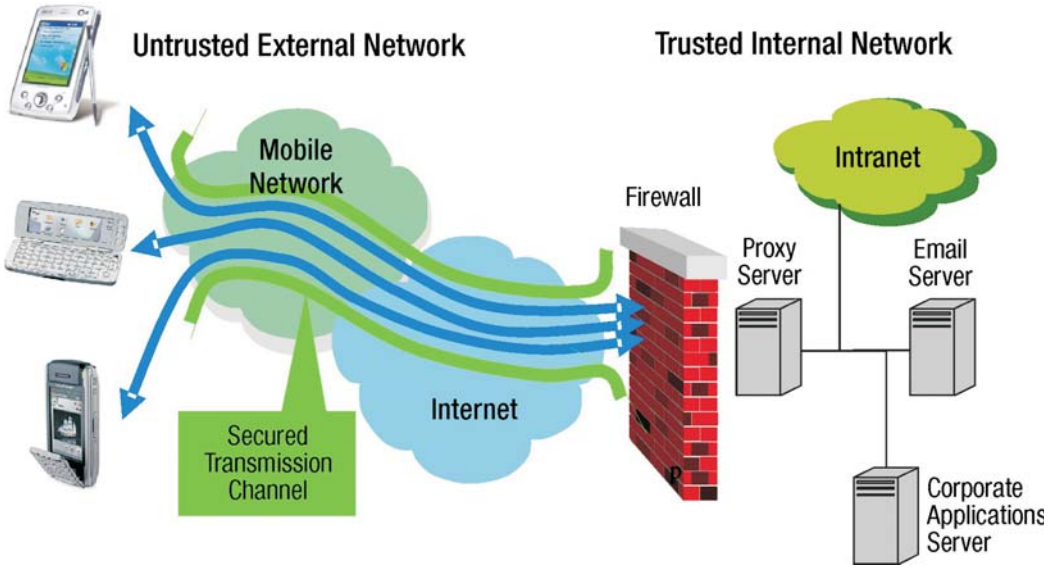

Figure 10. Corporate system access

Personal information applications could be used more efficiently with position information, such as calendar or contact applications with location dependency or a location-specific profile, access or alarm. PIM functionality is widened with the use of presence functions. Location-specific profiles could be made visible only to selected persons, through so-called buddy lists, and profile functionality could be activated with defined locations, *my locations*. Through the use of one's own locations, search activities and other directory services could be targeted more precisely. The most efficient services could combine the information of not only field force availability, but also location information and e.g. delays due to traveling from one place to another.

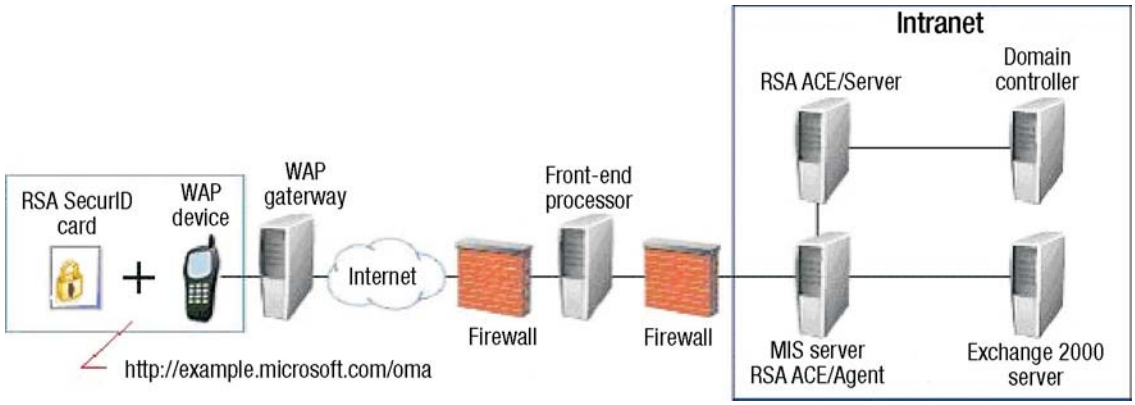

Figure 11. RSA SecurID authentication process

4.4.2 Horizontal basic functionalities

Most of the applications described earlier are based on basic functionalities of mobile phones and PDAs.

Messaging applications cover SMS (short message system, 160 char/message), Smart Messaging (the definition of how SMS is used to deliver ring tones, logos, pictures, business cards, calendar information, profiles, access configurations, bookmarks etc.), MMS (multimedia messaging, for sending text, still images, video, and voice or audio clips, to phone and email), and Instant messaging (messaging for group messaging/one-to-many, chat/many-to-many and between Internet and mobile domains).

Rich call applications are adding to the possibilities of a normal call: diverted calls, call subject, conference call, hands-free voice control, voice-enabled traffic service, voice-guided navigation services, voice recognition, text-to-voice, email2voice, synthesized voice and voice browser. Call session management for rich calls is made with SIP, the Session Initiation Protocol, which is a signaling protocol for Internet conferencing, telephony, presence, events notification and instant messaging. It is used to manage the all-IP sessions of future multimedia and mobile Internet services, and it enables the user to initiate and complete a number of different applications within a call session.

Downloading wirelessly (OTA, over-the-air) or with fixed wires enables the user to get necessary configurations, updated content or additional applications to the mobile device. Some applications have all their content on the server side and are based on continuous downloading, so-called streaming (e.g. games, music or videos).

The appendix A includes a more detailed list of horizontal applications. These applications are grouped under following titles: PIM, personal information mgmt, Mobile office/Mobile work place, Horizontal basic functionalities, Solving problems, Locating something, General information, Mobile Internet & Extranet access, Common corporate applications and Mobile shopping.

5 Technologies for mobile services and applications

This section presents the key technologies required for mobile services: the terminal types and their capabilities with connectivity methods ranging from cellular to local, application architectures to build the services on and enabling technologies currently in the standardization process. Finally, the key technical areas identified as critical for the development of the terminals and networks are presented with discussion of the special characteristics of application development for mobile services.

5.1 Mobile terminals

This section gives an overview of the currently available device types suitable for mobile use and wireless connectivity. We have deliberately left out portable versions of desktop PC devices (laptops, tablet PCs), since from the enterprise user's viewpoint they do not differ from their stationary counterparts in terms of applications and services. In Table 10 we have collected the key features of different mobile terminal types.

5.1.1 Mobile phones

Mobile phones targeted for business users are centered for person-to-person messaging: in addition to the standard numeric keyboard, a full qwerty keyboard can be supported for easier short message or email communication. Traveling enterprise users may also require support for a number of different cellular networks (multi-radio) within a single phone. Personal information management is usually supported by calendar and contact databases with remote synchronization. Special application needs can take advantage of the latest additions to the mobile phones, such as digital camera, video recording/streaming, instant messaging or push-to-talk service.

5.1.2 Smart phones

The term smart phone is used to characterize a mobile phone with special computer-enabled features not previously associated with mobile phones. In addition to functioning as an ordinary mobile phone, a smart phone's features may include: wireless email, Internet and web browsing, personal information manager etc. Typically, the functionality of the smart phone can be further enhanced with add-on applications. On the lower-end smart phones this may be limited to Java applications, but the higher-end devices usually provide an open environment for application developers to take full advantage of the underlying operating system functionality.

Although the overall market share of smart phones is very small, they have found their way to the enterprise users. Current smart phones targeted for enterprise users typically contain a color screen with a resolution of 180*210 pixels, 8-12 Megabytes of memory plus support for memory cards to further enhance the functionality with add-on applications.

5.1.3 PDA & communicator type devices

Most of the PDA-type devices on the market are based on the PalmOS or Windows CE operating systems with a touch-sensitive colour screen for pen input. Later models also include wireless connectivity support using WLAN or Bluetooth technologies, but cellular connectivity is only emerging with the very latest models. In the past, the main advantage, especially with Windows CE-based devices, has been better support for office environments typically based on Microsoft Windows tools. Communicator-type devices have been built around the connectivity, which can be considered an add-on feature with many of the PDA-type devices. These two device classes are rapidly closing in on each other as their features evolve: in addition to the pen input on the PDAs, miniature keyboards have also been added to ease text input for office environment applications. Also, the connectivity of the PDAs is getting better as cellular connectivity has been added. Similarly, Communicator-type devices provide a PDA-like look and feel: larger color displays up to 640*200 pixels, full keyboards and applications supporting office level applications for word processing, spreadsheets and email attachments.

Connectivity to the enterprise network infrastructure requires support for security; typically a secure VPN connection must be supported on the terminal to be allowed to

contact the company's confidential data or information systems.

Developing support for the various terminal types varies: for instance the tools and conventions used to create applications for the Windows CE platform are familiar to developers with past experience in the Windows environment. In contrast, new operating systems tailored for mobile terminals may have a very steep learning curve and more primitive development tools. However, this difference is diminishing as larger developer groups are shifting support to new operating environments and the tools are rapidly catching up to their competitors.

5.1.4 Summary of mobile terminal types

Table 10. Comparison of mobile terminal types.

	Laptop PC	PDA	Communicator	Smart Phone	Mobile Phone
	Dell latitude x 300	HP iPAQ h5550	Nokia 9500	Nokia 6600	Nokia 6820
Weight (g)	1320	210	222	125	100
Size (mm)	274x234x22	138x84x16	148x57x24	109x58x24	107x47x20
Display – size (pixels)	1024x768	240x320	640x200	176x208	128x128
Display – colors	16.7 M colors	65k colors	65k colors	65k colors	4096 colors
Memory	20-60GB HD 128-1024 MB	128Mb SDRAM, 48 MB Flash	80 MB built in + memory card	6 MB shared + memory card	3.5 MB shared
Operating System	WinXP	Pocket PC 2003	Symbian OS	Symbian OS	Nokia
Connectivity	WLAN, BT, IR, LAN, 56k modem	BT, WLAN, USB	EDGE, BT, WLAN, IR, USB	BT, GPRS, HSCSD, IR, GSM	EDGE, BT, IR
User Interaction	Full size Qwerty-keyboard, touchpad	Pen and Touch	Qwerty keyboard + 5-way joystick	Joystick, keyboard	Joystick, qwerty keyboard
Use on move	No	No (2 hands needed)	No (2 hands needed)	Yes	Yes
Expansions	Easy	Easy	Easy	Limited	Very limited
Price (€)	~1500	400	900	350	300
Apps	All business & office applications	MS-office integration, email, etc	MS-office compatible, email, etc.	Email, Calendar	Calendar, messaging

5.2 Connectivity technologies

The viewpoint in this chapter is to briefly summarize the current wireless technologies that will provide connectivity for enterprise users with mobile terminals. Therefore, the emphasis is on the data connectivity of each of the technologies presented rather than voice, SMS or MMS.

5.2.1 Cellular networks

The bulk of operator revenues are currently generated by voice traffic, but this is about to change with the introduction of new technologies enabling higher and higher data rates to the mobile terminals. The wildest forecasts estimate that data traffic will generate 25–30% of operator rev-

enues during 2006–2007 and will be more than 50% by 2010. From the original data rate of 9.6 kbps provided by GSM data, we are currently preparing for the commercial introduction of UMTS services with data rates up to 384 kbps. A summary of the features provided by the current cellular technologies follows, which presents the key advantages of the technologies.

5.2.1.1 GPRS/EDGE

In contrast to the circuit switched nature of the original GSM data (9.6 kbps) and HSCSD (43.2 kbps), GPRS and EDGE provide a packet switched data connection. With GPRS, the user sees an average 30–40 kpbs data rate and with EDGE 100–130 kbps (the theoretical maxima are higher but are not achievable in practice with the current implementations). As a rule of thumb we can relate these transfer speeds to typical throughput requirements for different applications [15]:

- Microbrowsing (WAP): 8–16 kbps
- Multimedia messaging: 8–32 kbps
- Video telephone: 64–384 kbps
- Web browsing: 32–384 kbps
- Enterprise applications: 32–384 kbps
- Video and audio streaming: 32–384 kbps

Currently, major operators in Finland provide GPRS service on their networks and EDGE service in major cities. The current consensus among operators is that EDGE services will not cover the whole network as GPRS does in the foreseeable future [1].

The current cost for a HSCSD data call varies from 0.22€ to 0.32€ per minute (about half of that for a basic data call of 9.6–14.4 kbps) depending on the operator. GPRS and EDGE data calls are charged per transferred data and vary from 1.5€ to 1.8€ at lowest per Megabyte.[1]

5.2.1.2 UMTS

Third generation cellular networks such as UMTS use the operator radio spectrum very efficiently to provide high data rates. The first commercial UMTS service was launched in Finland on October 12, 2004 by TeliaSonera and covers 20 major cities after a pre-commercial pilot started in December 2003. Elisa followed suit on November 23, 2004.

With UMTS, data services can be used at the same time as voice calls are made and the network supports end-to-end QoS (Quality-of-Service) negotiation between a mobile terminal and remote end. This mechanism can be used to guarantee that the quality of the data connection (data rate, delay, etc.) is maintained for the duration of the session. In practice, the user can expect to see data rates between 200–320 kbps (with bursts of up to 384 kbps) on the downlink and typically 64 kbps on the uplink. Compared to GPRS and EDGE, the latency (round-trip delay to traverse the network), has been improved from 600–700 ms to 200–300 ms, which enables near instantaneous user response in interactive services over the network.

Typical usage scenarios for the higher bandwidth provided by UMTS networks are the transfer of larger email attachments, audio and video streaming and video calls. As the data transfer rates and features continue to improve and the cost of the service is expected to decrease, new and more exiting applications and services will be feasible for wireless use.

Currently, the services of the UMTS network are priced similarly to the respective GSM or GPRS/EDGE services.

5.2.2 WLAN Wireless Local Area Networks

WLAN is offered by two major operators, TeliaSonera (HomeRun, approximately 245 sites nationwide) and DNA (dna WLAN, approximately 80 sites nationwide). In addition to these operators, there are a large number of WISPs (Wireless Internet Service Providers) that provide Internet connectivity for their customers using WLAN technology. However, WLAN technology is mostly used within companies for access to corporate Intranets, and is rapidly growing. A recent study by Meta Group estimates that about 30% of companies worldwide will be using WLANs by the end of 2004 and about 50% by 2006. About 40% of companies in Finland currently use WLANs[16] . Similarly, the number of public organizations using WLAN hotspot services is expected to increase significantly by 2005. Companies still planning to deploy WLANs are mostly concerned about the security aspects: earlier security implementations, such as WEP, have proven easy to circumvent. Recent enhancements, such as WPA 2 and IEEE's standardization work on 802.11i promise to correct this and provide enterprise level security for WLANs. Naturally, the security aspects can also be solved using another approach, such as VPN.

5.2.3 Local communication

Bluetooth was originally conceived as a wireless cable replacement solution but the specifications currently enable a multitude of applications, including hotspots for local communication. These hotspots can be independent devices without network connection that provide information services or applications for mobile users (software, ring tones etc.). If connected to a network, these hotspots can provide Internet access for email or web browsing, data or application download from enterprise Intranets or, for in-

1 Charges as of October 2004, including VAT 22%

stance, support for electronic payments at a point-of-sales location.

TeliaSonera's iJack concept was based on this approach: it can be used as a wireless local service spot to distribute mobile content to consumers during events or, for instance, to distribute catalogues or work orders to field personnel. However, this service only existed from August to November in 2004.

ZigBee is a proprietary set of high level communication protocols designed to use small, low power digital radios based on the IEEE 802.15.4 standard for wireless personal area networking. The ZigBee 1.0 specifications were ratified on December 14, 2004, but are currently available only to members of the ZigBee Alliance. ZigBee is aimed at applications with low data rates and low power consumption. ZigBee's current focus is to define a general-purpose, inexpensive self-organizing mesh network that can be shared by industrial controls, medical devices, smoke and intruder alarms, building-automation and home automation. The network is designed to use very small amounts of power, so that individual devices might run for a year or two with a single alkaline battery. The technology is designed to be simpler and cheaper than other WPANs such as Bluetooth. The raw, over-the-air data rate is 250 kb/s per channel in the 2.4 GHz band and 20 kb/s in the 868 MHz band. Transmission range is between 10 and 75 meters.

NFC (Near Field Communication) is a very short-range wireless technology operating in the 13.56 MHz frequency range for distances measured in centimeters. NFC is optimized for easy and secure communications between various devices without user configuration: to make two devices communicate, users bring them close together or even make them touch. The devices' NFC interfaces will automatically connect and configure themselves to form a peer-to-peer network. Targeted to become a widely adapted contactless infrastructure, NFC is already standardized according to globally accepted standardization bodies, such as ISO (18092), ECMA (340) and ETSI. Operating at data rates of 106 kbits/s and 212 kbits/s, NFC is compatible with Philips' MIFARE® (ISO 14443 A) and Sony's FeliCa smart card protocols. However, higher transmission speeds can be achieved between dedicated NFC devices – initially up to 424 kbits/s.

IR (Infra Red) and cable connection are still widely used to connect mobile terminals to PCs for data synchronization, backups or settings.

5.2.4 VPN

VPN, Virtual Private Network, is a network that is constructed by using public wires to connect nodes. For example, there are a number of systems that enable you to create

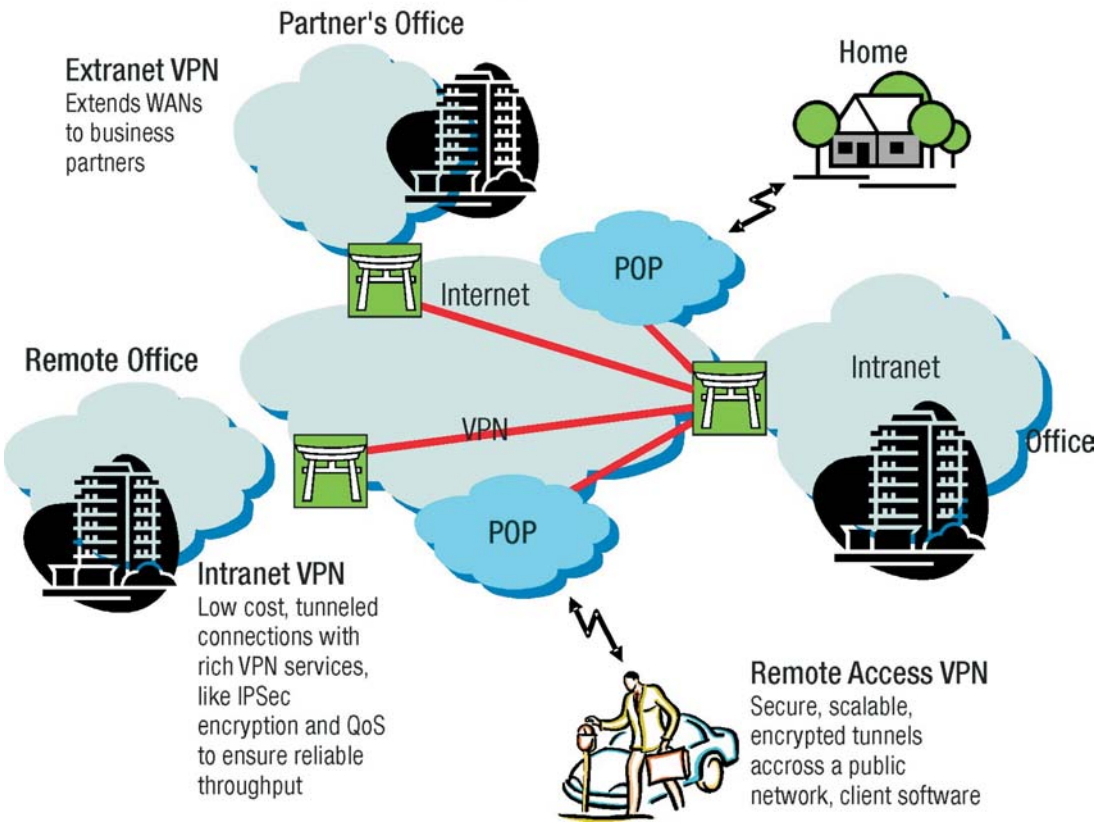

Figure 12. VPN Types

networks using the Internet as the medium for transporting data. These systems use encryption and other security mechanisms to ensure that only authorized users can access the network and that the data cannot be intercepted. VPN is used as an end-to-end security solution to provide the enterprise mobile workforce with secure connections to enterprise network resources. In a VPN solution, the VPN client has to interoperate with the server side VPN gateway with e.g. industry standard protocol such as IPSec that supports both legacy and PKI authentication.

5.2.5 Summary of connectivity technologies

5.3 New application architectures and services

5.3.1 Web services

Enterprise systems have been evolving from the tightly coupled client-server based paradigm towards physical and logical decoupling of the critical components of the architecture: the presentation, middleware, and database tiers. Currently, the leading architectures for the implementation of enterprise solutions are Sun Microsystems' J2EE (Java 2 Enterprise Edition) and Microsoft Corporation's .NET. Connectivity from mobile terminals to enterprise systems based on either J2EE or .NET architecture can be created,

Table 11. Summary of connectivity technologies

Network	Bandwidth	Coverage	Pricing model	Prices 12/2004	Possible use in business applications
GSM-data	9.6-14.4 kbps	GSM-coverage	Time	0.11-0.16 € per minute	WAP browsing, Email, M2M
HSCSD	Max 57.6 kbps	GSM-coverage	Time	0-22-0.32 € per minute	Email
GPRS	30-40 kbps	Almost GSM-coverage	Traffic	1.5-1.8 € per megabyte	Content services, email, MMS, WAP browsing, M2M
EDGE	Max 110 kbps	Major cities	Traffic	1.5-1.8 € per megabyte	Content services, email, MMS, WAP&WEB browsing
UMTS	Max 384 kbps	Major cities	Traffic	1.5-1.8 € per megabyte	Content services, email, MMS, WAP&WEB browsing, remote work
WLAN	512kbps – 4Mbps	Hotspots	Fixed/traffic/time	0.25 € per minute up to 90 € per month	Internet browsing, email, remote work
Bluetooth	Max 700 kbps	Hotspots	Service	-	Local (range up to 100m) services

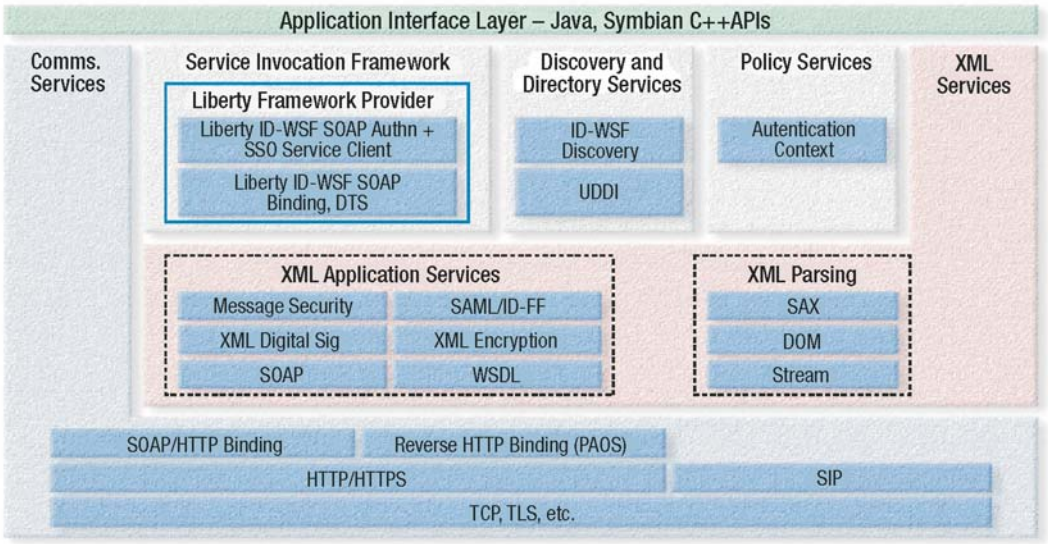

Figure 13. Nokia's view of future web services architecture

but in the case of .NET it is limited to platforms supported by Microsoft – J2EE has a larger base of supported platforms.

The concept of web services has been a hot topic as a non-proprietary solution for the loosely coupled enterprise system architecture evolution. Web services are still a work in progress since from the enterprise point of view some key requirements, such as security aspects, are incomplete. The standardization work is headed by W3C (World Wide Web Consortium), which defines web services as the following*: A Web service is a software system identified by a URI, whose public interfaces and bindings are defined and described using XML. Its definition can be discovered by other software systems. These systems may then interact with the Web service in a manner prescribed by its definition, using XML based messages conveyed by Internet protocols[17].*

Based on open standards such as XML and HTTP, web services are geared towards interoperability regardless of operating systems, hardware platforms or implementations. The web services paradigm will be encapsulated into J2EE and .NET architectures, but support for it is currently in its early stages, especially on mobile platforms. An example of what web services architecture on a mobile terminal could look like is presented in Figure 13.

5.3.2 Map services/OGC

ISO approved an International Standard developed by the Open Geospatial Consortium (OGC) on the November 1, 2004. The OpenGIS Web Map Service (WMS) Interface Specification was approved by a ballot of the national bodies that are members of ISO.

The OGC's WMS Specification (now also ISO 19128) specifies protocols that make it possible for HTML clients to have access to maps rendered by WMS enabled map servers on the Internet. Software that is in accordance with the specification enables automatic overlay of map images obtained from multiple map servers, regardless of map scale, projection, earth coordinate system, storage format, or vendor solution. WebMap Service can be understood as a gateway to a uniformly defined map database distributed around map servers on the Internet. FeatureMap Service can be used to search for maps from the desired area with required details. WMS viewers can be used to look at the map images that have been gathered by the WMS servers on the Internet.

5.3.3 Broadband services/OSGi

The OSGi (Open Service Gateway initiative, www.osgi.org) specifications define a standardized, component-oriented, computing environment for networked services. Adding an OSGi Service Platform to a networked embedded device adds the capability to manage the life cycle of the software components in the device from anywhere in the network. Software components can be installed, updated, or removed on the fly without ever having to disrupt the operation of the device.

The OSGi specifications were initially targeted at residential Internet gateways with Home Automation applications. However, the attributes of the standard made it applicable, and attractive, to other markets, like smart phones and vehicles (so-called AMI-C specifications). As an example, the OSGi Service Platform is a part of the BMW high-end telematics platform.

5.3.4 Open Mobile Alliance

Open Mobile Alliance (OMA) is an industry forum for developing market-driven, interoperable mobile service enablers. OMA's focus is on defining service and application level technical specifications, while leaving underlying protocols to be defined by other standardization bodies, such as IETF, 3GPP, W3C or JCP. OMA plays a key role in defining common practices for new services and applications for the mobile market. Most of the following new features are based on OMA's technical specifications and are already supported by the latest mobile terminals.

5.3.4.1 Digital Rights Management

The OMA DRM enables content providers to grant permission for media objects that define how they should be consumed. The DRM system is independent of the media object formats and the given operating system or run-time environment. The media objects controlled by the DRM can be a variety of things: games, ring tones, photos, music clips, video clips, streaming media, etc. A content provider can grant appropriate permissions to the user for each of these media objects. The content is distributed with cryptographic protection; hence, the Protected Content is not usable without the associated Rights Object on a Device. Given this fact, fundamentally, the users are purchasing permissions embodied in Rights Objects, and the Rights Objects need to be handled in a secure and uncompromising manner.

5.3.4.2 Instant Messaging and Presence

The OMA Instant Messaging and Presence Service [IMPS] provides the definition and promotes a set of universal specifications for mobile instant messaging and presence services. The specifications will be used for exchanging messages and presence information between mobile devices, mobile services and Internet-based instant messaging services.

A presence service allows users to create their own content and share it with others. It is also a dynamic variable profile of the user, which can be made visible to others and used to represent oneself, share information and control services. In a way, it is a service that is capable of telling others what

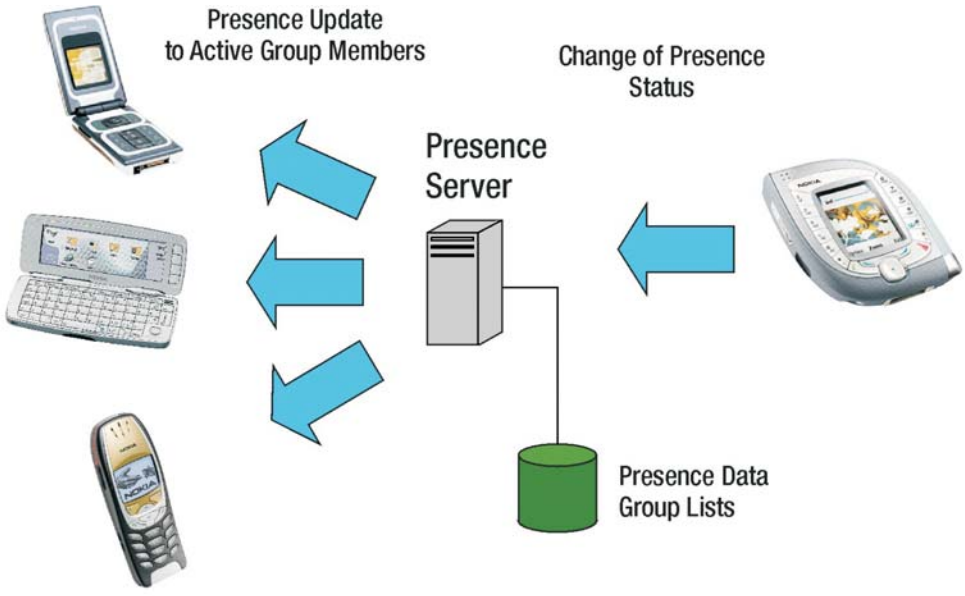

Figure 14. Presence service

Table 12. Attributes used in a presence service

OnlineStatus	Shows if the client device is logged on a presence server
Registration	Shows if the client device is registered in a mobile network
ClientInfo	Information about the client
TimeZone	Local time zone of the client device
GeoLocation	Geographical location of the client device
Address	Address of the client device
FreeTextLocation	Free text description of the location of the user
PLMN	PLMN code of the network the client device is registered with
CommCap	Communication capabilities of the client
UserAvailability	Availability of the user for communication
PreferredContacts	Contact preferences of the user
PreferredLanguage	Language preference of the user
StatusText	User-specified status text
StatusMood	Mood of the user
Alias	Alias name for the user
StatusContent	Media info for user status
ContactInfo	A vCard for the user

your status is and vice versa. Status contains information about your personal and device status, location or context, terminal capabilities and preferred contact method.

A presence service is offered by operators and enables them to offer various applications and services for new ways of staying in touch. The presence server manages stores and distributes the presence information as well as handles subscriptions and updates.

A presence service enables enhanced phone books and virtual coupling within different groups, such as family, friends and colleagues. Dynamic, personalized user profiles can be created and additional information, such as current activity, availability and location, can be added. This information is stored on the operator network and can be updated and shared with other mobile phone users.

5.3.4.3 Data Synchronization

The Open Mobile Alliance Data Synchronization specifications are based on the SyncML Initiative's Data Synchronization specifications and make use of the specifications as specified in the OMA SyncML Common specifications. The OMA Data Synchronization specifications provide the definition and promote a set of universal specifications for data synchronization.

The reason for the popularity of mobile computing and communications devices is their ability to deliver information to users when needed. Users want continuous access to information and applications from their device, and they want to access and update this information on the move. The target of synchronization is the ability to use applications and information on a mobile device, then to synchronize any updates with the applications and information back at the office.

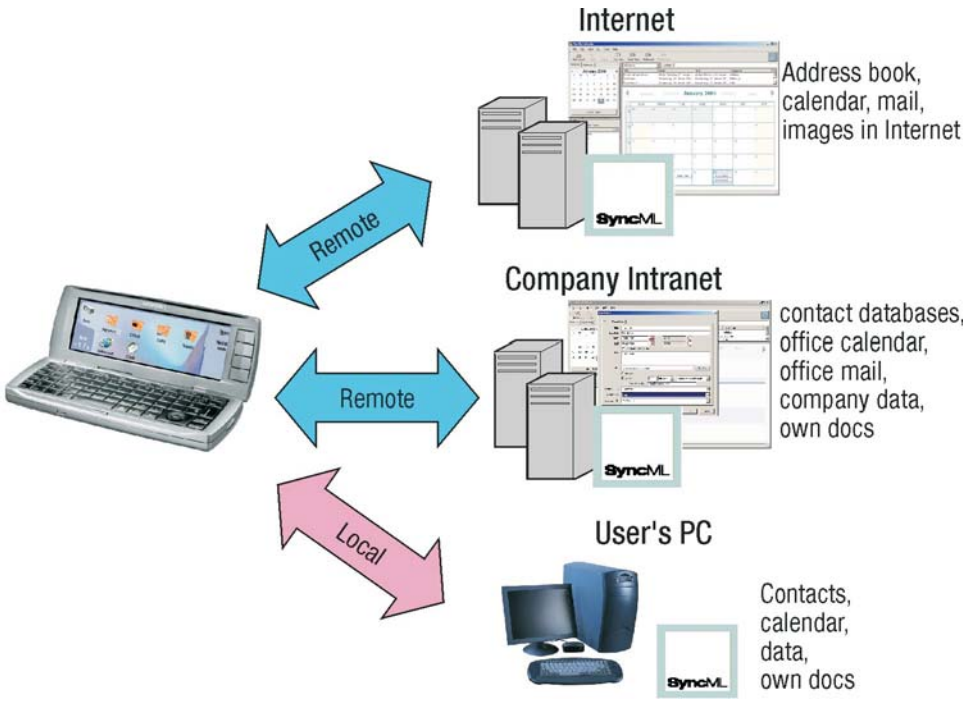

Figure 15. Synchronization services

Two approaches exist. A personal solution is made via access to Internet and the main information to be synchronized is PIM data. In corporate solutions the synchronization includes PIM data, but also data for various company-specific vertical applications.

5.3.4.4 Push to Talk over Cellular (POC)

The Push to talk over Cellular (PoC) service is a half-duplex form of communications that allows users to engage in immediate communication with one or more receivers, similar to Walkie Talkie type operation, simply by pushing a button on their handsets. Operator support for POC service in Finland is estimated to be commercially available during 2005.

5.3.4.5 Messaging

The OMA Messaging Working Group is responsible for the specification of messaging and the related enabling technologies. The goal of this activity is to specify a set of basic messaging features that may be used to enable specific messaging paradigms and to provide clarity of methods by which the messaging enablers are used as a medium for the interaction with different mobile applications.

Interoperability of the messaging services also exists; as a result, service conformance definitions for the messaging services will be produced. These may include dependencies on service affecting components which are not specified OMA (e.g. content or media formats, codecs, authentication methods).

5.4 Development of mobile technologies in the near future

The critical paths and critical points identified in [2] for network technologies and services include the developing role of terminals and networks. For mobile terminals, this means open software platforms, programming languages that are interoperable and standardized interfaces to terminal functions. To some degree these are already available and this development will continue; however, the number of dominating terminal platforms is likely to be smaller in the future.

Display technology will develop to support larger resolutions, available memory will grow to support larger applications and local storage of information while the overall power consumption will decrease. New radio interfaces (WLAN, RF-ID, DVB-H) will be added to the terminals on the path towards the development of Software Defined Radio (SDR). Sensor integration will provide information about the environment and behavior of the user enabling context aware services and applications.

These trends will enable the consumption of services available on the network with the one terminal the user is carrying – terminals can also be used for other purposes, such as mp3 player, radio/TV receiver, camera, remote controller or GPS device.

For mobile networks, the focus will be on enabling the management of heterogeneous network infrastructure and

exploitation of All-IP with IPv6 protocol with guaranteed end-to-end QoS (Quality-of-Service) and security while maintaining always-on, Always Best Connected (ABC) access. From one open network connection at a time, we will have many simultaneous connections to different services using different radio interfaces – management of this process without user intervention will be a critical factor for the success of future mobile services and applications.

New standardization activities will push the available wireless bandwidth past the current 54 Mbps with WLANs (802.11n net rates over 100 Mbps) for local connectivity, and for cellular networks the latest UMTS radio specifications (HSDPA) will lead to an increase from 384 kbps to 2 Mbps.

5.5 Other issues

5.5.1 Mobile application development

Lightweight, iterative processes are suitable for mobile applications development. There are two compelling reasons for adopting such agile development processes:

- Mobile technology is still in a developing phase. Applications need to get to the market fast as their lifespan is expected to be relatively short. According to Gartner, the lifespan of mobile solutions may be as short as 18 months, including development [7].
- Corporate mobile applications usually change working processes. These process changes also have social implications in the working environment. Predicting these social changes may not be possible, and the only way to tackle them is to adopt a collaborative, iterative and evolutionary approach to developing mobile applications [7].

Looking at the market by operating system, Symbian's global share increased to 50% from 30% in the same quarter a year earlier and was also up sequentially, from 41% in Q2 2004. Microsoft remains in the number two position with a 20% share, ahead of PalmSource at 17% [18].

Symbian's position in most regions is primarily shaped by Nokia's smart phone performance. In Japan, however, it is Fujitsu's success that underpins most of the operating system vendor's 78% mobile device share. In the US, only 6% of the mobile devices shipped in Q3 2004 ran the Symbian OS, compared to 43% for PalmSource and 25% for Microsoft [18].

While Symbian leads overall, it only operates in the voice-centric part of the market. For data-centric devices, Microsoft led in the quarter with a 45% share globally, up from 40% a year earlier, with PalmSource at 29%, down from 45% in Q3 2003 [18].

5.5.2 Tools for developing mobile applications

Current mobile development tools are on a par with the tools available for the desktop environments: both native and Java environments typically share the same tools with their desktop counterparts. However, the run-time environments are different, since with the desktop applications the target will be a computer which is exactly the same from the application's point of view, but with mobile devices this is not the case. During the development cycle of a mobile application, the code is typically run under an emulator simulating the target device and the actual device is used only in the finishing phase to make sure the application also runs on the mobile terminal it is targeted for.

Mobile terminal manufacturers rely on software houses (Borland, Microsoft) or open source (Eclipse) to deliver the tools for IDEs (Integrated Development Environment) that have a visual desktop for writing, compiling and debugging the applications. To support the special needs of the mobile terminals, the manufacturers provide platform or terminal-specific SDKs (Software Development Kit) to be integrated with the IDE. These SDKs typically include the platform-specific APIs (Application Program Interface) for device functionality, an emulator, special tools and documentation.

Worldwide total mobile device market
Market shares by operating system Q3 2004, Q3 2003

OS vendor	Q3 2004 shipments	% share	Q3 2003 shipments	% share	Growth Q3'04/Q3'03
Total	7,429,040	100%	4,061,420	100%	83%
Symbian	3,732,030	50.2%	1,238,170	30.5%	201%
Microdoft	1,503,950	20.2%	1,131,500	27.9%	33%
PalmSource	1,253,450	16.9%	1,218,010	30.0%	31%
Others	939,619	12.6%	473,740	11.7%	98%

Source: Canalys estimates c 2004 canalys.com ltd
"Mobile device market": feature phones, smart phones handhelds, wireless handhelds

Figure 16. Worldwide total mobile device market by operating systems

5.5.3 Testing of mobile applications

Reliability is a critical factor in mobile business applications. It is even more important than in consumer markets where the most important mobile services are entertainment-related. As mobile technology is becoming a seamless part of business processes, they must be robust, easy to use and dependable. As stated in chapter 5.5.1, development of mobile applications must also be very rapid. These requirements set high standards for the testing of mobile applications. It seems that testing is becoming a major issue in the mobile applications markets.

Based on interviews and [7], the main challenges for testing of mobile applications and services are

- The large amount of items to test. Application logic and functionality must be tested against programming defects, but networking issues also need to be tested as well as usability.
- Application platforms in mobile terminals are not quite mature yet. There are variations needed in the implementation of applications when platforms change, the version of the platform changes and the terminal changes, etc. Maturing and development of application platforms is expected to ease this situation. However, the current situation in the mobile applications market is that different versions must be developed for almost all terminal types/models. Even portable languages such as Java or protocols like WAP may not be interoperable in all terminals.
- Emulators and development environments for mobile applications need to be developed further. Currently they do not fully correspond to the features of mobile terminals. E.g. graphics and computational performance may differ between emulators and terminals.

In conclusion, there is a need for tools that support development and testing of mobile applications for all kinds of mobile terminal types. The general understanding seems to be that development tools and environments for Pocket PC platforms are currently more advanced than those for Symbian and other platforms.

5.6 Summary of mobile service implementation technologies

In Table 13 the characteristics of implementation technologies of mobile services have been summarized.

Table 13. Comparison of mobile service implementation technologies

	Java (J2ME) application	Messaging application	WAP browsing	WEB browsing	Symbian application	PocketPC	Windows application
Size of apps (max, kB)	30-100 kB	Built-in	Built-in	Built-in	Megabytes	Megabytes	Megabytes
Compatibility between different terminals	++	+++	++	++	+	++	+++
Interfaces to terminal functionality	++	+	-	+	+++	+++	+++
Ease of development	++	+++	++	+++	+	+++	+++
Role of mobile operator	Optional	Mandatory	Mandatory	Mandatory	Optional	Optional	Optional
Pricing	Medium	Low	Low	Low	Medium-high	Medium-high	High
Performance	+	+-	—	-	++	+++	+++
Networking	IP	SMS/MMS	WAP	IP	IP	IP	IP
Ease of use	++	—-	+	+	++	++	+++
Number of supporting terminals	++	+++	++	+	+	+	+++
Deployment	OTA PC Memory card	Built-in	Built-in	Built-in	OTA-supported Typically PC or memory card	PC Memory card	LAN CDROM
Investment costs	Low	Low	Low	Low	Medium	Medium	High
Development tools	Many (PC+Linux)	Few	Few	Many	Many (PC + Linux)	Some	Numerous

6 Discussion

An important part of this research was interviews of persons involved in developing mobile business applications. There were almost 20 persons interviewed during October – December 2004. The interviewed persons represented the following stakeholders: applications developer, mobile terminal manufacturer, mobile operators, system integrators, healthcare organizations, manufacturing industry, building and transport and services businesses, such as logistics and banking

Issues raised in the interviews will be discussed in this section. The discussion has been classified into the following sub-categories: mobile business application markets, services, terminals, networks and other issues.

6.1 Mobile business application markets

6.1.1 Value networks/chains in mobile business service markets

It seems that there is no clear and shared understanding of the structures of the value networks of mobile services. Mobile business applications markets are currently emerging and structures will be clarified in (most likely) a few years. The identified stakeholders in the value network of mobile business services are mobile operator, application developer, system integrators (including corporate IT-providers), terminal manufacturers and customers. In consumer markets, mobile operators play a key role in business networks. In business services systems, integrators are in a stronger position.

It is important for a company developing services or applications to identify target business network and distribution channels in an early phase of development, since these issues are most likely to have an impact on design decisions. The interviews indicated the desire to join forces regarding R&D between different stakeholders for cooperation on a wider base, instead of niche application areas to extend value chains between large and large/small enterprises.

There has been a lot of discussion about open platforms and standards. Despite the great steps gained in shared platforms, it is good to keep in mind that standards and basic systems are largely open, but the corporate solutions based on them are mostly proprietary solutions.

6.1.2 Better tools and methods for mobile services are needed

Management and maintenance of mobile terminals over the air is a very important feature in business applications (as well as consumer apps).

The development cycle of (mobile) business services should be short. New mobile business services have a great influence on business processes. The impact of mobile services in business processes and the way people work is really difficult to anticipate. Perhaps the best way to tackle risks in applying mobility in business processes is the adoption of an iterative and fast development process. This enables quick response in case of difficulties. Another factor favoring fast development processes is that mobile terminals become outdated in a very short time. Mobile programming platforms attempts to tackle this problem but current situation is not quite satisfactory (e.g. comparing to PC-applications). One way to accelerate the development of emerging new mobile services is naturally the use of well-established enablers like SMS or browser interfaces.

There are currently a number of competing application platforms available for building mobile applications and services. These platforms are not compatible with each other. This causes lots of additional work for application developer. Tools to help developers implement applications for various platforms at once would make the work more efficient.

There is a need for tools to help developers handle various applications platforms and versions of platforms

Testing of mobile applications is a relatively laborious task. There are many features and functionalities for testing. Currently, it is very difficult to test and verify applications in all the different hardware and software environments. Improved interoperability is needed.

6.2 Services

6.2.1 Service discovery is a challenge in consumer markets

Service discovery refers to a mechanism and/or process to discover the location of mobile services that can provide the user with the information or functionality he or she is interested in. In mobile consumer markets, users currently

find services mostly from other media such as newspapers and magazines. Consumer users do not know where to find mobile services when on the move. Mobile browsing-based solutions are not currently easy, usable and fast enough to provide a good use experience and added value for an occasional user of mobile services.

If services and applications are part of the business process, then configuration and set-up should be part of the whole concept. However, in consumer markets service discovery is a great challenge.

6.2.2 Mobile browsing or mobile application-based approach

There seems to be two main approaches to implementing services in the mobile end. The mobile browsing-based approach takes advantage of wap or web browsing. In the application-based approach, there is a process-specific client application used in mobile terminals.

An application-based approach may offer better possibilities to integrate a mobile application into business processes. Optimization of data traffic between the terminal and servers is easier to implement in mobile applications. Usability-issues are critical in any service or application. Comparing to browsing, application-based approach provides better possibilities for improved usability in mobile services. Also off-line use may be easier to implement in mobile applications than in browsing.

Based on experience in the IT –world, browsing-type services have many advantages over the application-based approach. For example, easier and more cost effective maintenance and support of services and better interoperability are important advantages of the browsing approach. In mobile services however, limited bandwidth reduces the attractiveness of the browsing-based approach. The small size of displays also favors application-type services. As bandwidth in mobile networks gets higher and terminals get larger displays, browsing-type services will become a more competitive option. Meanwhile, there seems to be markets for the mobile application business.

6.2.3 Multi-channel delivery of services

Information-oriented services could benefit from multi-channel delivery, i.e. delivery of content through many different communication channels. The field service force could download the main parts of their information from their computer to their mobile devices or in the garage to the in-vehicle system while preparing their vehicle for their daily tasks. A multi-channel delivery mechanism makes it possible to download the necessary data through the most efficient, available channel, thus decreasing transmission costs. The key issue is to create content only once, but use it in multiple ways and via multi-channel delivery.

6.2.4 Added value from mobile services

There seems to be a need in both consumer markets and business use for more information about useful mobile services and successful utilization of mobile technology to solve real-world problems. This may be due to the non-existence of these beneficial and useful services, but the real problem may also be in the missing advertising and marketing of these new possibilities.

In business use, the most important added values of mobile services are related to money. There should be more information about the productivity implications of mobile services in business use. One should also be able to analyze and calculate the degree of improved productivity and the scale of return of investments.

There is a lack of reliable and independent research on the productivity implications of mobile services and applications in business use. There may be various reasons for non-existence of this information. First of all, companies may consider calculation of Return of Investment (ROI) confidential and a source of competitive advantage and do not want to publish that information. Secondly, there are very few public research on productivity implications of mobile services in businesses. And thirdly measuring the ROI may be a very difficult task because of business process changes and indirect influence (e.g. improved customer satisfaction) of these services.

This kind of information would be very beneficial for businesses considering investments in mobile technology. It could also make the general attitude more positive towards mobile business services.

In consumer markets, the added value of mobile services needs to be considered differently. The main focus in the Finnish mobile business currently seems to be on price competition for mobile voice calls and short messages. Much less advertising has been invested in marketing the possibilities of more advanced mobile services. It is unlikely that regular users will start searching for new services if they do not know where to find them, how to find them or how to use then – or why to use these services.

There has been lots of technology-oriented marketing in the history of mobile services. Need and desire-elements should be added to the marketing. In addition to technology and need, there should also be a working business system behind the mobile services so that they would be able to provide added value both for users and the service provision network.

The value of consumer services will decrease, but corporate services will maintain their value. This is due to a different approach with consideration to added value. In consumer markets, entertainment issues such as novelty value have a certain importance. In business services, however, the benefits gained through the process change enabled by mobile services do not vanish together with novelty value.

6.2.5 Mobile services as new product features

There is a trend in businesses to combine added-value services with current products. Information services have been linked to existing products. These value-added services will be launched in order to diversify from competitors and to improve customer service and customer loyalty. In the first phase, these added-value services can be, for example, delivery of product-related information to the customer. In the long term, these added-value services can also have an effect on product and services design. An example of this development would be the possibility to upgrade control SW in an electronic device during the lifetime of the product.

6.2.6 Foreseeable mobile services in the near future

As discussed in earlier sections, there are a large variety of different types of mobile business services. These services differ from each other in terms of ease of integration into business processes. It is likely that those services that are easiest to integrate into business process will also be those that become common rapidly.

Mobile email (especially push email) is likely to become a successful service. There is an obvious need to be able to access email outside the office. There are also mature technical solutions as well as business models for mobile email. The integration of mobile email into business processes is relatively loose; therefore it is relatively easy to put into use. Email clients are also available as a built-in feature in a number of mobile terminals. Faster connection speeds supported by UMTS enable transfer of large email attachments to the mobile terminal: viewing these attachments is possible because the processing speed and available memory are growing as well.

Calendar is another obvious service to become mobile. There are already calendar-solutions available that provide users with support for both individual use as well as group use. Calendar applications are a basic functionality of mobile terminals and handheld PDA-devices.

Access to information in corporate information systems using mobile terminals other than laptop PCs is an important feature in various application domains. This feature can be used by various kinds of mobile workers. The tasks to be carried out when mobile include e.g. reporting and data collection, as well as access to different kinds of information in corporate IT systems, such as stock data and product information,

Peer-to-peer technology has enabled new business models in various business services in the Internet domain. It will be interesting to see whether it also turns out to be as interesting a technology in the mobile domain.

The fees paid for mobile data traffic is one component that needs to be considered in a business models for mobile services. In some cases, it may be an interesting approach to take advantage of the lower cost of data traffic outside business hours or the quiet time in the network at night to download content to mobile terminals.

In healthcare, mobile technologies offer good potential for improved efficiency in processes utilizing remote expert type services. An example of this kind of scenario is a doctor having a consultation or making a diagnosis based on information delivered to him or her via mobile service. On the one hand, this kind of application could accelerate the processes and, on other hand, enable expert services in sparsely populated areas. Challenges in this kind of scenario are a lack of suitable and usable terminals, network coverage of mobile broadband networks, and security and legislation concerning health data. As healthcare and wellness services move to homes, new activities for monitoring and measurement arise: M2M-based vital sign measurement equipment needs real-time, wider bandwidth and IP–level connectivity to sites providing healthcare services. Mobile terminals can act as gateways between measurement devices if they support local communication (Bluetooth, ZigBee); however, the functionality must be as easy to use as possible in order to be accepted.

Mobile payment will affect the value chains of retail and distribution: value chains will be shorter and some players may even leave the business. In many cases, mobile service solutions have been seen as an activity to increase the degree of self-service in business. An example of this kind of service might be mobile check-in for airlines.

M2M, fleet management, healthcare and wellness are promising application fields for mobile business services.

PoC, SIP, IMS and Presence are seen as key new enablers for completely new services and level of usability for services, especially in terms of managing group communication and group communication itself.

6.2.7 Content-related issues

At the end of the day, the content processed in mobile services is the most important thing. That is what (mobile) services are for. The nature of the content varies a lot. In the consumer market, the most valuable content seems to be ring tones and Java games. At least these are the things customers are ready to pay for. In business use, content is naturally business-related information.

In mobile services, it is important to be able to provide the user with the content or services he/she is willing to receive and use. Location-based services have been considered one of the most promising solutions for providing users with as correct and timely relevant information as possible. Relevant and timely content at the correct location is one of the key drivers of location-based services. For instance, public transportation (buses, metro etc.) can be used as a source for locally distributed information, advertisement and services.

Content sharing between peers is an important (popular) functionality in the Internet. It is likely that the same trend or need is also present in the mobile Internet. Mobile technology enables the users to be connected with each other all the time. This kind of approach allows people to easily share content with a large group of other people in a relatively inexpensive way.

6.3 Terminals

Mobile terminals are the key component in mobile services. Together with the connectivity solution, they provide the basis for mobile functionality. Terminals are developing in terms of emerging new functionality and the improvement of current ones. Manufacturers introduce new terminals at a really fast pace. For example, Nokia introduced more than 40 new terminal models during 2003.

During the interviews, there were a few main issues raised concerning mobile terminals. The most important issues are programming platforms (e.g. Symbian, PocketPC, etc), development tools and processes, user interface issues and the testing of mobile services and applications. Tools for managing a wide spectrum of terminals are non-existent: current tools can only solve certain categories, and a key challenge is to get services and applications to the terminals as easily as possible.

6.3.1 Compatibility between versions of programming platforms in mobile terminals is a great challenge

Current mobile terminals are very rich in terms of features and functionality. Mobile terminals have relatively high processing power, enormous storage capacity and good connectivity options. This is especially true for PDA devices, which have developed from the IT community. Mobile phones also have good capabilities for running applications. This especially applies to the so called Smart Phones.

There are a number of different programming platforms to be taken in account when considering the mobile service/application business. In business, use of Symbian-based mobile terminals is stronger in European markets. PocketPC and Palm-based devices, on the other hand, are important in US markets. Asian markets have other alternatives. It is important to note that target markets and business strategy play an important role when selecting the platform and device base for services. In the long run, other operating systems may also become interesting in mobile terminals. Such operating system may be e.g. Linux.

Application platforms are not fully compatible with each other or even between different devices using the same application platform.

There have been various attempts to handle compatibility issues in mobile services. Languages such as Java have not yet been able to solve the problem. Another approach to solving the compatibility problem is the use of the browsing approach. This approach also has limited capabilities to solve the compatibility issues. Web services will be one approach to provide interfaces to services and enablers.

6.3.2 Usability

The user interface and usability are a major challenge in mobile applications. The usability of mobile devices varies quite a lot. Some of the device manufacturers have invested energy in developing their device interfaces; some are merely based on existing features of the operating system. From the business application viewpoint, PDAs are seen as being difficult to use, due to their complex user interface. The Windows CE functionality and its stylus control are not regarded as a natural way of using advanced applications; some training for its proper use was even requested. Mobile phones, especially smart phones, are easier to use. The experiences in application development show that the development tools and equipment of mobile phones are not as advanced as for PDAs.

Usability of the service is the most critical requirement for the success of the service. Part of the usability experience of device users comes through the overall usability of the device, its general UI hardware and software. The total usability experience of the application and service depends on e.g. how the application is capable of easily getting a detailed request from the user, how wide coverage the gathered content has and how quickly the service response is made.

Naturally, the size of UI in a mobile terminal is restricted. In addition to the small size of the UI, there are also various different sizes of displays in mobile terminals. This causes a lot of additional work in the production of mobile services when different version of services must be developed for almost all different terminal types.

Since the user interface is restricted in mobile terminals, the input is even more restricted. It can be said that current mobile terminals are not well-suited for input-intensive applications. Technologies that help users in input tasks would ease the use of mobile services. Such technologies are e.g. context awareness technologies such as positioning.

6.3.3 Other terminal-related issues

There is a lack of terminals designed for professional use. Terminals for field force applications should have a rugged design with larger keys – current terminals are not suitable for these kinds of applications.

In some services, there is a need for support for mobile payments and certificates; micropayments and verification of transactions need RF-ID/NFC support, and in order to be widely deployed this needs to be simple. Most, if not all, of the required bits and pieces are already available or standardized – only the inertial momentum to push these services for wider acceptance is still needed.

Terminals that support the correct radios are not yet in the market. In terms of UMTS+EDGE+GPRS service coverage, a drastic drop of service level when leaving UMTS service and dropping directly to GPRS with a terminal that has no EDGE support can be a problem in some cases. However, most business use cases are not too sensitive to this (eMail etc.).

6.4 Networks

6.4.1 There is good coverage for mobile networking technologies

Transmission rate is not the key issue: coverage, reliability and indoor functionality are. Mobile network coverage in western countries is at a sufficient stage to start building and use mobile business services. The current situation is that GSM networks are available virtually anywhere, GPRS connectivity is also available almost as widely as GSM. UMTS networks are also emerging. Mobile business users are willing to pay for effortless remote connectivity, but a challenging research question is how to present a complex wireless connectivity environment to a user in an easily usable way. This means that the network in use (GSM, UMTS, WLAN, Bluetooth) needs to be selected according to the user's preferences, but easily. Higher bandwidth will enable the building of larger integrated applications and will provide critical mass for a wider spectrum of applications. As bandwidth rises, the duration of session will be longer meaning that more tasks will be done during a single session. On the other hand, All-IP will enable easy end-to-end communication between services and applications.

The number of WLAN hotspots is increasing. This will surely have an impact on the business models of mobile services. Higher bandwidth also makes new kinds of working models possible.

Local connectivity and Bluetooth-based information and content delivery will create new business opportunities. In particular, in-store advertising and CRM type applications are naturally suited for local connectivity-based services. Bluetooth is already a standard feature in various mobile phones. This is especially the case in business category models.

Even though the coverage of mobile networks is relatively good on all continents and in most countries, the situation in the target markets needs to be evaluated carefully. The situation concerning the coverage, costs and reliability of communication capabilities can be radically different, even in areas that are close together. Communication capabilities in the target market may have a huge impact on the applied business model.

6.5 Other issues

6.5.1 Change management and human factors are challenging in the start-up phase of mobile services

New mobile information systems have an impact on business processes. Sometimes these changes may be quite radical. Therefore, starting up a new mobile business service is not only a technical challenge but also a challenge to the organization and people working in the organization. Organizations and people may not be able to change the way they work quickly, and the change may require compromises between the "optimal" and existing ways of actions.

Human factors in launching new business applications must also be taken into account. New working methods, such as utilization of a mobile service, require new capabilities from workers. Therefore, a start-up project may be needed in many cases in order to put the mobile business service into practice. In addition to the technical implementation of the mobile system, the start-up project should at least include training of workers and stakeholders. Support services as well as user interface issues are naturally important, but there are also other issues to be considered. Labor legislation-related issues and privacy of workers should be considered carefully. For example, location-based services may be problematic in terms of the sense of privacy of workers.

A common saying is that change is the only permanent thing in today's businesses regardless of business sector. This pressure for continuous change requires that information systems, including mobile systems, be very flexible in order to adapt to changing situations. An interesting question is whether mobile business solutions could be seen as a tool of change management.

6.5.2 International co-operation

In terms of mobile services and applications, Japan has been a target for many researchers and visitors; this should be continued and expanded to include, for instance, South Korea, which is currently not only active in the terminal business but also very active in introducing new services.

7 Summary

The factors that characterize the current state of mobile business applications and development in the near-future have been discussed in this report. The analysis has been based on background analysis of mobile business services and applications markets and interviews with 19 Finnish experts.

The group of interviewed persons comes from two sectors: the enablers and the potential users of mobile business services. The enabler sector included representatives of a mobile device manufacturer, mobile operators, mobile application developers and system integrators. The cluster of potential users included representatives from the healthcare and wellness sector, service business sector, media, traffic, industrial services and tourism.

The challenges for mobile services are mostly non-technical: currently available technical enablers for creating new services are sufficient for most of the needs arising among the prospective users of mobile services. The real challenge lies in understanding the needs of the customer and whether a mobile solution responds to these requirements – mobility does not solve every problem. Introducing a mobility aspect to a business practice can change the processes related to the way the business is conducted and who are the players in the new value chain or network. In addition to changing current businesses, it will create new ones.

The key findings of the interviews have been listed below:

- It seems that there is **no clear and shared understanding of the structures of value chains/networks for mobile services**. Mobile business applications markets are currently emerging and structures will be clarified in a few years. It is important for a company developing services or applications to identify the target business network and distribution channels in an early phase of development, as these issues most likely have an impact on design decisions. The interviews also raised the desire for joining forces in R&D and process development between different stakeholders to achieve cooperation on a wider base instead of niche technical application areas to extend value chains between enterprises.
- **Incompatibility between terminal programming platforms** is a great challenge for the developers and operators/IT managers: when to use a specific application instead of a browser-based approach? Supporting a vast number of terminals (version management) and configurations (terminal management) is a major risk: there are no tools to manage this as a general solution. Basic development tools are on a par with their desktop counterparts; however, tools to support the development of mobile services are still lagging behind.
- **Mobile services are best suited to tasks with a need of real time information without high requirements for large displays or input capabilities**. However, there are special needs in, for example, healthcare and wellness services where these are required; for instance, a consulting specialist in the medical imaging field requires large displays and wide bandwidth data rates to the terminals. Field force operations may require terminal capabilities (ruggedness, better user interface, low weight and power consumption) that are not widely available in current mobile terminals. For M2M applications, there is clearly a need for real-time connectivity (IP–level vs. SMS) and higher bandwidth, especially in healthcare and wellness applications.
- Mobile networks could provide better bandwidth, but **good coverage is more important from the mobile business services point of view**. Very few services require the highest possible data rates to the terminal; however, seamless connectivity is important and mobile connectivity is of key importance for multi-channel services. A positive factor of increasing data rates is that it prolongs the sessions – the user does more things during one session.
- **Mature technologies and fast, iterative processes** should be used for implementing mobile business services: the lifespan of a mobile application is very short, mobile terminals evolve rapidly and deployment of mobile services in business may have unexpected effects which needs quick reaction. Open standards-based technical decisions as well as open interfaces to enablers and services enable faster development.
- **Usability** is the number one requirement for a successful mobile service: a mobile solution that cannot be easily located, requires complex settings or is not easy to use will never be accepted for or create a successful business. Terminals that are best suited for mobile services are typically higher end devices. The cost of the terminal may not be a limiting factor for business users but to reach a major market and wide acceptance this will be a slowing factor.
- **Connections to/from existing corporate IT systems** to mobile terminals and an efficient way to use these applications when outside the office.
- Promising new mobile services, such as **mobile payments, rich call and group communications are seen as the next major enablers** for new businesses: these are already standardized and waiting to be launched.

Acknowledgements

A list of interviewed persons has been presented in Table 14.

Table 14. List of persons interviewed

Person	Organization
Ala-Ruona Jari, CEO	Movial
Alasalmi Tuomas, CEO	Rokuan kuntokeskus
Hanhimäki Jorma, CEO	Vega Technologies
Haukipuro Kari, Head of Division, Surgery	Northern Ostrobotnia Hospital District
Jalkanen Juha, Assistant Vice President, R&D, Service Innovations	Kone OYj
Joona Jouni, Director	TeliaSonera OYj
Kanniainen Liisa, Vice President, Mobile Banking	Nordea OYj
Kivi-Koskinen Harri, Director of Business Development	TeliaSonera OYj
Kivistö Kari, CTO	MSG Software
Koistinen Pasi, Director, Future Business Creation	TeliaSonera OYj
Lehmus Pasi, Director, Products	Elisa OYj
Luuppala Harri, Vice President, Media&Telecom	Tietoenator OYj
Niskanen Mika, Project Coordinator	Tampere region
Pitkänen Pasi, IT Service Manager	S-ryhmä
Rainio Matti, CEO	TKL
Ranta Sami, Senior Manager, Strategy Development	Nokia OYj
Spets Jouni, Business Director, Mail Order Services	Posti
Turpeinen Marko , Vice President, Research & Technology	Alma Media Interactive
Vaara Sakari , CEO	Celesta mBusiness Oy

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Appendix A

Summary of horizontal applications

The rows in the following tables carry the names of identified services, which have been grouped based on conclusions from the interviews, surveys of various business sectors, conference presentations, and information on the websites of international forums and system manufacturers. The columns express the following: second column – type of service (person-to-person/person-to-system), third column – terminal application (native, original applications installed by the manufacturer/browser, application made on browser/specific, specially made application for particular use), fourth column – location of the content (in server, all content in infrastructure server/in terminal, all content in user terminal/distributed, content partly in terminal, partly in server), fifth to ninth columns – business sectors. The number of Xs in the cells refers to the suitability of the service to the particular business sector, three Xs for a well-suited case and no Xs for a not so suitable case.

Table 15. Examples of horizontal mobile applications

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/Browser/ Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Business services	Industrial services	Building and construction trade	Forest industry
	P/S	N/B/S	S/T/D					
PIM, personal information mgmt								
Calendar (with location)	S	N/B/S	D	XX	XXX	XX	XX	XX
Contacts (with location)	S	N/B/S	D	XXX	XXX	XXX	XXX	XXX
Directory service	S	B/S	S/D		XXX		XX	
My locations	S	B/S	D	XX	XX			
Location-specific profile	S	S	T	XXX	XXX			
Location-dependent access	S	N	S	XXX	XXX	XXX	XXX	XXX
Location-dependent alarms	S	B/S	T	XXX	XX			
Phonebook	S	N	D	XXX	XXX	XXX	XXX	XXX
Presence	S	N/B/S	D	XXX	XXX	XX	XX	XX
Buddy lists	S	B/S	D	XX	XX		XX	
Mobile office/Mobile work place								
Email	S	N	D	XX	XXX	XX	XX	XX
Calendar	S	N	D	XXX	XXX	XXX	XXX	XXX
Corporate address book	S	B/S	D	XX	XXX	XX	XX	XX
Authentication	S	N	S	XXX	XXX	X	X	X

Table 15. continues...

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/Browser/ Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Business services	Industrial services	Building and construction trade	Forest industry
Directory service	S	B/S	S		XXX		XX	
Fax	S	N	D	X	XXX	XX	XX	XX
Information search engines	S	B	S	X	XX	X	X	X
Browser	S	B	D	X	XX	X	X	X
Address change	S	S	S	X	X	X	X	X
Horizontal basic functionalities								
SMS	P/S	N	D	XX	XX	XX	XX	XX
MMS	P/S	N	D	X	XX			
Email2voice	S	S	S		XX		XX	
Rich call	P/S	N	D		XX			
Conference call	P	N	D	X	XXX	X	XX	X
Hands-free voice control	S	S	D	X	XX	XX	XX	XX
Voice-enabled traffic service	S	S	D		X	X	XX	X
Voice-guided navigation services	S	S	D		XX	XX	XX	XX
Voice recognition	S	S	D	XXX	XX	XX	XX	XX
Text-to-voice	S	S	D	XX	XXX	X	X	X
Synthesized voice	S	S	D	XX	XXX	X	X	X
Voice browser	S	S	D	X	X			
Downloading	S	N	D		XX			
Rights management	S	N	D	X	XX			
Content formats	S	N	D	XX	XX	XX	XX	XX
Authentication	S	N	D	XX	XX			
Streaming media services	S	N	D	X	X			
Download media services	S	N	D	X	X			
SIP	S	N	D	X	XX	X	X	X
Solving problems								
Locatable eCall	S	N	D	XX	X	X	X	X
justrightBreakdown service	S	S	D	X	XX	X	X	X
Roadside assistance	S	S	D	X	XX	X	X	X
Warning about unsafe areas	S	S	D	XX	XX	X	X	X
Nearest medical center & doctor	S	S	D	XXX	XX	X	XX	X
Theft emergency	S	S	D	X	X	X	X	X

Table 15. continues...

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/Browser/ Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Business services	Industrial services	Building and construction trade	Forest industry
Automatic door lock	S	S	D		XX		XX	
Phone-off automatism (e.g. hospitals, airplanes, facilities)	S	N	T	XX	XX		XX	
Towing service	S	S	D	X	XX	X	X	X
Safety and security services	S	S	D	X	X	X	X	X
Quick service needs	S	S	D	X	XX	X	X	X
Emergency alerts	S	S	D	X	X	X	X	X
Locating something								
Location messaging	S	S	D	XX	XXX	X	XX	X
Finding locations (navigation, homing, guiding)	S	S	D		XX		XX	
Route description	S	S	D		XX		XX	
Turn-by-turn navigation	S	S	D	X	XX		XX	
Dynamic route guidance with maps	S	S	D	X	XX		XX	
Location-based chat	P	S	D	X	XX	X	XX	X
Personal navigation	S	S	D	X	XX		XX	
Mobile local call (tariff reductions)	P	S	S	XX	XX	XX	XX	XX
Home zone with particular services	S	S	S	XX	XX	XX	XX	XX
LBS on information search	S	S	D	X	XXX	X	XX	X
YP: Search engine for companies, offices, factories, people	S	S	D	X	XXX	X	XX	X
Finding a friend	S	S	S	X	X		X	
Finding trucks, cars (fleet mgmt)	S	S	D		XX	X	XX	XX
Logistics management	S	S	D			XX	XX	XX
Workforce management	S	S	D	XX	XX	XX	XX	XX
Industry-specific location ID	S	S	S	XX	XX	XX	XX	XX
Finding valuables (e.g. assets, stolen car, cargo)	S	S	D		XX		XX	
Person surveillance	S	S	D	XX	XX			
General Information								
Yellow pages	S	S	D	X	X	X	X	X
Point of interest	S	S	D	X	XX	X	X	X
Traffic info	S	S	D		XX		XX	
Weather info	S	S	D		X		XX	XX

Table 15. continues...

Name of the service	Person-to-person (p)/ person-to-system (s)	Native app/Browser/ Specific app	Content in Server/ Terminal/Distributed	Healthcare and wellness	Business services	Industrial services	Building and construction trade	Forest industry
News	S	S	D	X	X	X	X	X
Event guide	S	S	D	X	X	X	X	X
City guide	S	S	D	X	X	X	X	X
Tourist information	S	S	D	X	X	X	X	X
Timetables	S	S	D	XX	XX	X	X	X
Dynamic travel itinerary	S	S	D	X	XXX	X	X	X
Map	S	S	D	X	XXX	X	XX	X
Parking (finding & paying)	S	S	D		XX			
Ordering (taxi, pizza, services)	S	S	D	X	X	X	X	X
Road tolls	S	S	D		XX		XX	
Mobile coupons	S	S	D		X	X	X	X
Synchronization								
Synchronization of corporate data	S	S	D	X	XXX	XX	XXX	XX
Groupware, e.g. Lotus Notes, MS Exchange	S	S	D	X	XXX	X	XX	X
Mobile Internet & Extranet access								
Mobile corporate Intranet	S	B	D	XX	XXX	XX	XX	XX
Company mobile portal	S	B	D	X	XXX	X	X	X
Mobile extranet	S	B	D		XX	X	XX	X
Buyer's real time connection to company information system	S	B	D		XXX	X	XX	X

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