HELSINKI UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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UTILISATION OF WIRELESS APPLICATION PROTOCOL TECHNOLOGY IN INTERNATIONAL EXTRANET BUSINESS

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ENGINEERING AT THE HELSINKI UNIVERSITY OF TECHNOLOGY

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Tämä tutkimus käsittelee mobiilipalveluiden ja Internetin konvergenssia yrityspalveluissa. Tutkimuksen tavoitteena on antaa teknis-taloudellinen yleiskuva WAP -teknologian hyödyntämisestä extranet -liiketoiminnassa. Aihetta tarkastellaan pääasiassa palveluntarjoajan näkökulmasta.

Tutkimus on jaettu kahteen pääosaan. Teoriaosuudessa käsitellään uusien palveluiden kehittämisen problematiikkaa, extranet -verkkoja sekä WAP -protokollaa. Tutkimuksen empiirinen osa sisältää WAP -pohjaisten extranet -palveluiden esittelyn, järjestelmätasoisen teknisen kuvauksen sekä kaupallisen analyysin.

Yritysten extranet -ympäristöissä on karkeasti jaoteltuna kaksi ongelma-aluetta: kommunikaatiokanavien hallinta ja tietoturvallisuus. Business-to-business -portaali on yksi tapa ratkaista nämä ongelmat. Se tarjoaa yksittäisen liityntäkohdan extranet -sovelluksiin sekä yhtenäisen tietoturvallisuuspolitiikan. Mobiilikäyttöliittymä portaaliin parantaisi kommunikaatiota ja tarjoaisi lisäarvoa asiakkaalle.

WAP -protokollapino luo suoran yhteysrajapinnan TCP/IP -protokollan ja mobiiliaseman välille sekä määrittelee sovellusympäristön, johon kuuluvat päätelaitten rajoitukset huomioonottaen suunniteltu selain, skriptikieli, lisäarvopalvelut ja tarvittavat sisältöformaatit.

Mahdollisia WAP -teknologian sovelluksia yrityksen extranet -verkossa ovat tiedonvälityspalvelut, tietokantakyselypalvelut, asiakaspalvelut, uutis- ja keskustelukanavat, langaton sähköinen kauppa ja sovellushallintatoiminnot. Uusia palveluita voi myös kehittyä uuden teknologian myötä. Käsitettä langaton business-to-business -portaali voidaan käyttää tässä yhteydessä vastaamaan WWW -pohjaista portaalia. Langaton portaali siis sisältää saman toiminnallisuuden kuin kiinteissä verkoissa, mutta sovitettuna mobiiliympäristöön. Mahdollisia kohdeasikkaita näille uusille palveluille olisivat innovatiiviset, teknologiapainotteiset ja verkottuneet yritykset, joilla on tarvetta langattomaan kommunikaatioon.

Kaiken kaikkiaan WAP -teknologialla on vielä pitkä tie kuljettavanaan. Tämänhetkiset arviot ennustavat menestystä langattomille datapalveluille, mutta todelliset menestystarinat ovat mahdollisia vasta useiden vuosien kehityksen jälkeen.

Avainsanat:	WAP, extranet, portaali, mobiili, GSM, Internet

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ABSTRACT OF MASTER'S THESIS

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This study deals with the convergence of Internet and mobile world in the business-to-business environment. The objective is to give an overall picture of how the new WAP technology could be utilised in the extranet business. The point of view is mainly the service provider's. Both technical and business aspects are considered.

The study is divided into two main parts. In the first part, the theory of new service development, extranets and WAP protocol stack are discussed. The second part of the study is empirical. The possible WAP-based extranet applications are discussed. The technical implementation of wireless extranet infrastructure and the problems in it are presented. A business analysis of the case is also performed.

There are two main problem areas in developing company extranets: managing communication channels and security. The business-to-business portal concept is one way to solve the problem. It offers a single access point to extranet applications and enforces a common security policy. Wireless access to the portal would improve the communication and offer additional value to the customers.

WAP protocol allows the direct interfacing between a TCP/IP medium and a mobile station medium and it specifies an application environment including a microbrowser, scripting, telephony value-added services and content formats.

The possible applications of WAP technology in a company's extranet include information delivery services, database query services, customer services, discussion groups and news services, wireless e-commerce and service management functions. New applications can also emerge with the new technology. The wireless business-to-business portal concept can be used to correspond to the web-based portal. This portal has the same function as in data networks and the same kind of applications, but accommodated in the wireless environment. The possible target customers for the new mobile services are innovative, technology-oriented and networked companies that have a need for mobile services.

All in all, WAP technology has still a long road ahead. All the current forecasts predict success for mobile data services, but the true success stories will be reality only after several years.

Keywords:	WAP, extranet, portal, mobile, GSM, Internet

PREFACE

This study has been conducted for Sonera Ltd. during September 1999 – January 2000.

I would like to thank my instructors, Sakari Luukkainen and John Saario. Mr. Luukkainen gave valuable comments and guidance at the beginning and at the end of the writing process. Mr. Saario provided me with advice and the facilities to work efficiently and was also extremely flexible with my other work duties. Without their help my work would have been much more difficult.

Finally, I would like to thank my dear parents. Without you and your love I would have never got this far.

Helsinki, 20 January, 2000

Tapio Ranta

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BS	Base Station
CGI	Common Gateway Interface
CPS	Critical Path Scheduling
DES	Data Encryption Standard
EDI	Electronic Data Interchange
GUI	Graphical User Interface
HTTP	HyperText Transfer Protocol
JDBC	Java Database Connectivity
IP	Internet Protocol
IRC	Internet Relay Chat
IRR	Internal Rate of Return
ISP	Internet Service Provider
LDAP	Lightweight Directory Access Protocol
MMI	Man-Machine Interface
MSC	Mobile services Switching Centre
NNTP	Network News Transfer Protocol
NPV	Net Present Value
ODBC	Open Database Connectivity
OSI	Open Systems Interconnection
PDA	Personal Digital Assistant
PPP	Point-to-Point Protocol
QFD	Quality Function Deployment
RAS	Remote Access Server
ROI	Return on Investment
SMS	Short Message Service
SQL	Structured Query Language
SSH	Secure Shell
SSL	Secure Sockets Layer
TCP	Transaction Capabilities Protocol
TLS	Transaction Layer Security

URL	Uniform Resource Locator
VPN	Virtual Private Network
WAE	Wireless Application Environment
WAP	Wireless Application Protocol
WDP	Wireless Datagram Protocol
WML	Wireless Markup Language
WSP	Wireless Session Protocol
WTA	Wireless Telephony Application
WTLS	Wireless Transaction Layer Security
WTP	Wireless Transaction Protocol
WWW	World Wide Web
XML	Extensible Markup Language

1 Introduction

1.1 Background

The rapid growth and success of the Internet and mobile phones have created new markets. The companies, consumers and service developers have experienced the growth as the wide offering of new products and services in both fields. The Internet has become perhaps one of the widest technological success stories of our century. The development of mobile applications and devices has only a short history, but has been and will probably continue being one of the most rapidly growing industries ever.

However, until now, these two worlds have been quite far apart and developed independently. Of course, laptops and mobile phones and palm top devices have offered some degree of mobility, but the actual integration of the IP world to the world of mobile phones has been complicated and awkward.

The business world has developed a lot of various mobile applications for its needs and some of them have proved to be working solutions. In the past, analogous phone-based message passing systems have been in use in logistic solutions and laptops and card phones are largely used in mobile offices. The real problem has been a lack of a truly global standard for mobile applications. Until now, there has been no consensus between the interest groups: the device manufacturers, service providers and network providers.

The mobile phones are developing rapidly and the new models include more and more multimedia capabilities. The multimedia capabilities include the ability to retrieve email, and push and pull information from the Internet. In order to guide the development of these exciting new applications, the leaders of the wireless telecommunications industry formed the Wireless Application Protocol Forum. [40]

The founder companies of the forum were Nokia, Ericsson, and Motorola and the handheld device software platform developer Phone.com (formerly Unwired Planet). The forum was established in June 1997. Since then, it has experienced impressive membership growth with members joining from the ranks of the world's premiere wireless service providers, handset manufacturers, infrastructure providers and software developers. [40] The former national telecom operator of Finland, Sonera, is also a member of the WAP Forum.

The WAP Forum has the following goals:

- To bring Internet content and advanced data services to wireless phones and other wireless terminals.
- To create a global wireless protocol specification that works across all wireless network technologies.
- To enable the creation of content and applications that scale across a wide range of wireless bearer networks and device types.
- To embrace and extend existing standards and technology wherever possible and appropriate. [40]

The deployment of this new protocol specification is now taking its first steps and the formation of new services has started. It is expected that a part of the services that have previously been on the Internet could now be transferred to mobile devices and this possibility should be thoroughly studied in all business areas. It opens a set of whole new business prospects and naturally every player in the Internet and mobile markets has interests to take part in the business.

There are a variety of forces at work causing a convergence of cell-phone and Internet technologies:

- Prices of mobile phones, computers and related services are decreasing.
- Both computer technology and mobile phone processing power is increasing.
- Cellular networks, spurred on by the new digital technologies, are becoming more capable.

- The primary end-user markets of both mobile services and Internet services are business-to-business.
- End-users are increasingly more mobile. [21]

The development and growth of the Internet has, on the other hand, created various new concepts. The areas of IP-based business communication is now divided into three development phases: first the Internet, then intranets the most recently, extranets. This evolution can be seen as a result of the technology development and growing awareness of the possibilities of IP-based services.

This study is made for Sonera Solutions, a subsidiary of the Sonera Ltd. Sonera has already launched its consumer WAP services and there is quite a lot of knowledge and know-how on wireless technology and on the business inside the company. Sonera Solutions has been developing its corporate extranet services and there are several products that have already been launched or coming to the markets, but the integration of WAP technology to these products has not been implemented nor studied thoroughly.

1.2 Definition of an Extranet

An extranet can be viewed as a physical and logical network of computers and devices that resides on the outer perimeter of the company's internal network. It adheres to its own security policy that is distinct from the security policy of the company intranet or the on connecting to the Internet. Thus, access to the extranet itself is usually limited from the Internet and intranet sides by forcing some form of access control. [33]

Building blocks of an extranet are the physical and logical networks and the collection of services targeted exclusively for business partners. The services run on servers and other network devices present in the extranet network and are usually also distributed to some intranet servers and to the client software. The extranet is not limited to the physical context of one network and can span multiple networks. A more exact definition of the extranet limits is based on the function an extranet service fulfils. [33]

Thus, the extranet is collaborative Internet-based technology that creates a network to link businesses with their suppliers, customers or other external business partners and facilitates productive intercompany relationships [10, 46]. So, in this study, the extranets are seen as a part of the services that exploit Internet technology.

An integral part of the extranet is, and must be, the set of access control measures that keep the logical network following the security policy defined for it. [33]

1.3 Research Problem

The development of WAP technology has caused a lot of discussion among the professionals. The public image of this concept created by different media has caused a situation, where the true nature and value of the technology has blurred. Research-based information on the subject is buried under different visions and beliefs. The answers to the basic questions are unanswered. Is there any real business opportunities in the technology? What is the added value that this new technology can bring? Especially unclear the situation is on the corporate business. The extranet services are a part of this business and they offer a good platform to study the possibilities of the new technology. Thus the research problem can be stated as

How could the WAP technology be utilised in the extranet service provision business to increase sales and obtain new customers?

1.4 Objectives of the Study

As a consequence of the research problem, the main objectives of the study are

1. to define the corporate customers' needs and problems in their extranets or in building one
2. to explain the WAP technology concept and its added value compared to other existing technologies
3. to define what needs and problems the WAP technology could solve in extranets

4. to examine what business opportunities the wireless extranet could offer to a service provider and how they should be used

This thesis has also secondary objectives. They are

1. to find out what wireless extranet services could be implemented with current end-user devices and protocols
2. to present some solutions how to integrate WAP to the current infrastructure of an operator
3. to discuss the general problems and challenges in developing new services and in using new technologies

1.5 Scope of the Study

This study concentrates only on the extranet business for corporate customers. The study is made for Sonera Solutions that provides services for the top 400 largest companies in Finland. The extranet business is chosen because it offers an excellent product portfolio of different IP-based services and there is a need to investigate the possibilities of mobile technologies on these markets.

The WAP technology parts concentrate on the GSM-based services, because it is the most widely used system in Europe and that's where Sonera's customers mostly operate at the moment. GSM networks are also currently growing in the USA. However, there are no reasons why the business-related sections and the service descriptions should not apply on other mobile bearers as well.

This study aims to offer a general picture of the subject. The main approach is business -oriented. The technical points are considered to a reasonable extend and WAP is presented as thoroughly as it is needed to deal with the subject. After all, the research problem cannot be addressed without a complete understanding of the technology. The main emphasis is put on the features that can be seen important from the point of view

of extranet business, namely security and application capabilities. The applied technical matters are only investigated at a system level; the details are left out.

1.6 Research Approaches and Methods

This study includes the introduction to the extranet markets and services. WAP and GSM technologies are shortly outlined. Subsequently, the empirical part of the study discusses the use of the technology in the given environment. The reasoning chain starts from the customer needs and ends in the solutions and added value that WAP technology can bring to these needs.

The method used in this study is mostly literature study. Literature survey consists of various books, research material, market researches and magazine articles dealing with extranets, WAP technology and the business area in general. The internal documents of Sonera Solutions products are also used to some extend. Sonera's experts on the WAP technology and extranet products are interviewed to get more detailed view of the business and the products.

1.7 Structure of the Study

The thesis is divided into seven parts. Chapter 1 introduces the reader to the topic, defines the research problem and the objectives of the study. The essential concept of an extranet is defined. Chapter 1 also describes the scope and structure of the study as well as the research approaches and methods.

Chapter 2 deals with the problem of new service development. Different sources are studied to get an overall picture of problems and challenges in developing new market offerings and using new technologies and bringing the services to markets. Some scientific methods to measure the different parameters in the development process are also presented. These methods are then later used, when analysing the meaning of the mobile services.

Chapter 3 gets the reader acquainted with the customer's needs and problems in building an extranet. The different extranet services are presented. The extranet service provision business concept is presented. Some information is also given on the current market trends and different platforms.

Chapter 4 introduces the WAP technology concept. The architecture overview and the different protocols in the current specification are presented. WAP technology is also compared with the current technologies and the added value that WAP can bring is discussed. Different end-user devices and their effect on the services are presented.

Chapter 5 starts the empirical part of the study. The possibilities of WAP technology in extranet services are analysed. The possible applications, where mobility and wireless WAP devices could be used are presented. The chapter also includes a discussion of using the current devices and protocols in these applications. An example user interface and usage session sequence is outlined.

Chapter 6 examines the technical aspects of integrating the WAP technology into the infrastructure of a service provider. The possible protocol stacks on the network boundaries, the different interfaces and the security issues are discussed at a system level.

Chapter 7 is a business analysis of the case. It addresses questions of customer delivered value, risks, marketing, pricing and billing, evolution of services and general market forecasts. Chapter 8 concludes and sums up the results of the study.

2 New Service Development

2.1 Challenges

This chapter addresses the problems in developing new products and services using new technologies and standards. The problem is examined from the product development's point of view as well as from the business point of view. The purpose of this chapter is to present the theory and tools for answering the research problem.

Less than 10 percent of all new products are truly innovative and new to the world [17]. The solutions studied in this thesis are basically value-added services, additions to the existing products. The main reasons why new products fail are [17]:

- A high-level executive pushes a favourite idea through in spite of negative market research findings.
- The idea is good, but the market size is overestimated.
- The product is not well designed.
- The product is incorrectly positioned in the market, not advertised effectively, or overpriced.
- Development costs are higher than expected.
- Competitors fight back harder than expected.

These reasons are caused by different elements in the value chain. The first one is a personnel problem and quite out of reach of this thesis. Product design and development cost problems are mainly caused by the product development, while competition, advertising and estimation of markets are tasks taken care of by marketing, management or product management. There are challenges for every part of the development process and failing of any of these can cause the failure of the new product. This is why answering the research problem requires the examination of the subject from different points of view. As WAP services are a combination of two

technological environments that have previously been apart – the Internet and mobile world – the co-operation between the experts of both environments is essential.

The new product development as a target of scientific study is fairly new, and there are currently not so many reliable sources available. The points of view of the sources also differ greatly. The following two examples show how there are various possible approaches to the same subject.

Kotler states that there are several factors to hinder new service development [17]:

- Shortage of important ideas in certain areas: There may be few ways left to improve some basic products. This point is addressed in Chapter 5, when considering the possible services that can be implemented with WAP technology.
- Fragmented markets: Keen competition is leading to market fragmentation. Companies have to aim their new products at smaller market segments, and this can mean lower sales and profits for each product. Chapter 7 discusses the target customers for mobile extranet services and commercialisation of the new value added services.
- Social and governmental constraints: New products have to satisfy consumer safety and environmental concerns. Government requirements slow down innovation and business, for example, in exporting data encryption algorithms. The factor of strong encryption exporting is shortly addressed, when discussing the extranet services in the general level in Chapter 3.
- Costliness of the development process: A company typically has to generate many ideas to find just one worthy of development. Furthermore, the company often faces high R&D, manufacturing, and marketing costs. Evaluating costs and profits is outlined in Chapter 7.
- Capital shortages: Some companies with good ideas cannot raise the funds needed to research and launch them. The problem of capital shortages and raising funds is not seen as essential from the point of view of large operators and therefore not addressed in this study.

- Faster required development time: Companies that cannot develop new products quickly will be at a disadvantage. Companies must learn how to compress development time by using computer-aided design and manufacturing techniques, strategic partners, early concept tests, and advanced marketing planning. Alert companies use concurrent new-product development, in which cross-functional teams collaborate to push new products through development and to market. The organisational aspects of the development process are not addressed in the scope of this study.
- Shorter product life cycles: When a new product is successful, rivals are quick to copy it. Competitor analysis and product life cycle estimation are carried out in Chapter 7.

On the other hand, Lester has listed sixteen factors that hinge new product development. These factors are divided into five main areas [20]:

1. Senior management commitment
2. Organisational processes and structure
3. Attractive new product concepts available for development
4. Venture teams with appropriate staffing and resources
5. Project management

According to Lester's model, this study addresses only very limited part of the problem, because the management and organisational issues are not discussed. Only technical and economical-related issues are examined in this study.

2.1.1 Technology and Standards

The technologies and standards have always been among the most critical problems in new service and product development. That is, the services that are based on some new technology or emerging standard are also dependant on the success of the standard itself. There are several cases where a new product has been introduced and it has required the use of a standard that has not been supported by every party, and therefore the product has not gained popularity. The question is about compatibility and not

really about the technology. This is also the case with WAP technology and integrating it with current IP-based extranet services.

When two (or more) incompatible technologies struggle to become a de facto standard, we say that they are engaged in a standards war [27]. The key assets involved in a standard war (or in successful introduction of a new standard or technology) are [27]:

1. Control over an installed base of customers. Control over and installed base can be used to block co-operative standard setting and force a standards war.
2. Intellectual property rights. Firms with patents and copyrights controlling valuable new technology or interfaces are clearly in a strong position.
3. Ability to innovate. Beyond your existing intellectual property rights, the ability to make proprietary extensions in the future puts you in a strong position today.
4. First-mover advantages. If you already have done a lot of product development work and are farther along the learning curve than the competition, you are in a strong position.
5. Manufacturing abilities. If you are a low-cost producer, owning to either scale economies or manufacturing competence, you are in a strong position.
6. Strength in complements. If you produce a product that is a significant complement for the market in question, you will be strongly motivated to get the bandwagon rolling.
7. Reputation and brand name. A brand-name premium in any large market is highly valuable.

These seven points can be seen as the key assets, when a company is launching a new product or service that is based on a standard or a technology, that is not yet de facto. These points are considered in Chapter 7, when evaluating the possibilities of Sonera to succeed in launching WAP-based extranet services.

Worth mentioning are also the concepts of switching costs and lock-in [27]. Once you have chosen a technology or a standard of a service, the switching can be very expensive (for the customer or for the service provider). If a new service is introduced that is based on a new technology, this might be a failure because of the enormous

switching costs for the customer. That is, the added value of the service itself may not exceed the switching costs.

Lock-in, on the other hand, is a situation where an old, out-of-date technology is used, for example because switching costs to a newer system would be significant. Lock-in arises whenever users invest in multiple complementary and durable assets to a particular information technology system. Today's state-of-the-art choice is tomorrow's legacy system. [27] In a way, it can be said that there is a lock-in with SMS technology in the current mobile phone environment.

From the point of view of the research problem in this study, the convergence of the Internet and the mobile technologies may cause a diversification in the provision markets of extranet services. That is, the different technologies will cause the service providers to form groups and networks. The reason for this division is the ability of the service providers to support a certain technology. These groups can also be formed by partnerships between the service providers and the technology vendors. The choice to provide solutions with one technology (for example WAP) causes a lock-in to this platform and therefore may also threaten the market position of the service provider. On the other hand, division of resources and the attempt to support all possible technologies may scatter the resources too much and cause too many extra investments.

If an extranet service provider chooses not to support the mobile technologies for example because of the large switching costs, its position may be threatened. It may turn out that the added value of WAP is higher than expected and the customers are willing to pay and change the service provider to be able to provide mobility to the end-users. In this scenario the traditional service providers will be in a difficult situation.

2.2 *From Idea to Product*

2.2.1 Idea Generation

The marketing concept holds that customer needs and wants are the logical place to start the search for ideas [17]. In other words, the customer has a problem and the idea is developed to solve the problem. Technical companies can learn a great deal by studying their lead users, those customers who make the most advanced use of the company's products and who recognise the need for improvements before other customers do [17].

The other way to generate ideas is to study the products and services of company's competitors. Sales representatives, distributors and suppliers act as sources of information. These groups have firsthand exposure to customers and are often the first to learn about competitive developments.

New product ideas can come from other sources as well, including inventors, patent attorneys, university and commercial laboratories, industrial consultants, advertising agencies, marketing research firms, and industrial publications. Although ideas can flow from many sources, their chances of receiving serious attention often depend on someone in the organisation taking the role of product champion [17].

In this study the approach is theoretical. It became clear when discussing with the experts that the customers do not yet have enough information on the new technologies that they would be able to initiate new service ideas. The presented possible extranet services are mainly speculative and based on the author's own ideas. WAP technology is in a special position, because the first applications implemented with it are business-to-consumer services. Normally in Internet and mobile markets the development of new services has started from the corporate environment. In this case, the consumer applications also offer some basis for creating service concepts in the business-to-business environment.

2.2.2 Idea Screening

This chapter presents two methods for analysing the success of product development with a new technology. These methods are used in the business analysis part of this study and they offer some guidelines on the development of WAP services. The methods work in general level and fit well into this case, because there are not much detailed information available on the WAP business-to-business applications.

The ideas that are seen as potential can be weighed using weighted-index method like in Table 1. The first column lists factors required for successful product launches, and the second column assign importance weights. The third column scores the product idea on a scale from 0 to 1.0, with 1.0 the highest score. The final step multiplies each factor's importance by the product score to obtain an overall rating. In this example, the product idea scores .69, which places it in the "good idea" level. The purpose of this basic rating device is to promote systematic product-idea evaluation and discussion. It is not supposed to make the decision for management. [17]

Table 1. Weighted Index Method

	Relative Weight	**Product Score**	**Product Rating**
Product Success Requirements	**(A)**	**(B)**	**C=A x B**
Unique or superior product	.40	.8	.32
High performance-to-cost ratio	.30	.6	.18
High marketing dollar support	.20	.7	.14
Lack of strong competition	.10	.5	.05
Total	1.00		.69

Rating scale: .00-.30 poor; .31-.60 fair; .61-.80 good. Minimum acceptance rate: .61

As the new product idea moves through development, the company will constantly need to revise its estimate of the product's overall probability of success, using the following formula [17]:

Overall Probability of Success	=	*Probability of technical completion*	x	*Probability of commercialisation given technical completion*	x	*Probability of economic success given commercialisation*

The company then has to judge whether this probability is high enough to warrant continued development.

2.2.3 Concept Development

Ideas must be refined into testable product concepts. Idea is a possible product the company might offer to the market. A product concept is and elaborated version of the idea expressed in meaningful end-user terms. [17]

Concept development includes methods for positioning the product in product-positioning map and in brand-positioning map. These two maps clarify the positioning of the concept in general market and feature terms. The company needs to decide the most important differentiating features of the concept and its positioning on the markets compared to its existing possible competitors.

Success is derived from understanding and meeting customer needs. A technology meets a customer's needs, if the technology performs some task the customer desires. Therefore, for the successful commercialisation of a new technology, one has to determine both the application or function the technology is to fulfil and the customer groups or market segments that will be most interested in the technology and its function. Because technologies can be offered into many potential customer segments with several different applications or functions, management must decide on which of many possible positionings to take, as illustrated in Figure 1. [9]

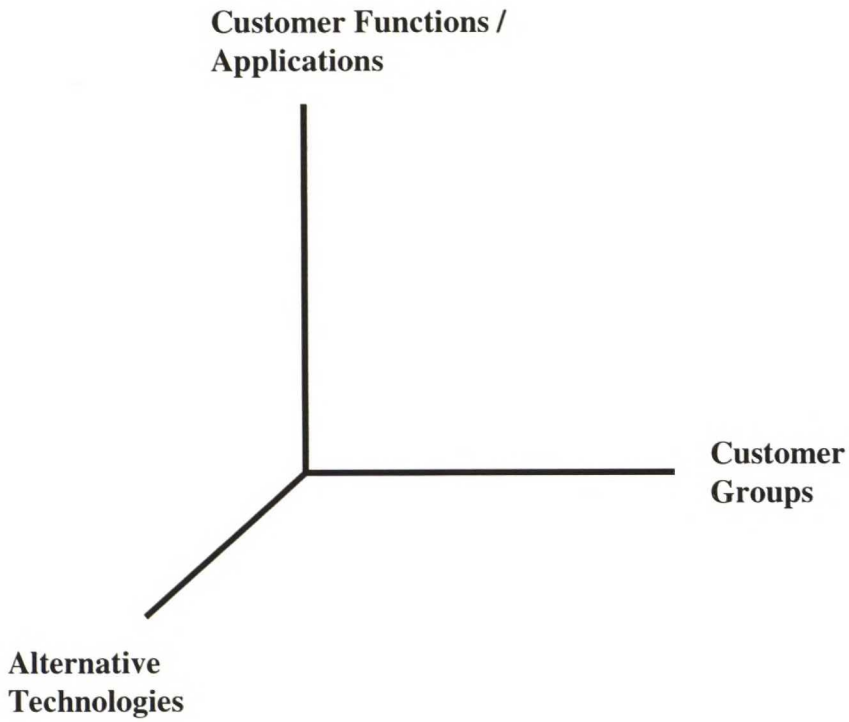


Figure 1. Market Segmentation [9]

The different customer functions and applications in mobile extranet are presented in Chapter 5. The question of alternative technologies is addressed in Chapter 6. Customer groups, i.e. the target customers for mobile extranet services are analysed in Chapter 7. These three axes form the basis for the business analysis of provisioning mobile extranet services.

2.2.4 Product Development

If the planned service or product passes the business tests, it moves to R&D engineering to be developed into a physical product. This step involves a large jump in investment that has not been seen in the earlier steps. There may have been prototypes or only written descriptions of the product.

There are techniques to better understand customer need in the design phase of a new product. All of them employ the same general strategy: first, identify the customer groups; then discern the needs or functions; finally, develop the technology to meet the

customer needs. This general approach is appropriate in most cases, because the majority of innovations are incremental. In these cases, the markets already exist, and the targeted functions and customers are well known. The incremental innovation replaces an existing product by being better, faster or cheaper. [9]

This study only offers the first steps of the incremental process and it uses the same basic methods described in this chapter. The applications can truly be developed and the true customer need may be defined only after the piloting of the services and after there is experience of real customer cases.

2.3 Business Analysis

The new service development process includes several decision points where business analysis and tools are needed. In Kotler's model, the business and technical decisions are mixed together and a solid development process is created. The reality is not perhaps so straightforward. Usually, the business decisions and technical decisions are made separately and by different people and that's why they are dealt with separately in this study. This chapter deals with the business aspects in the new service development process using mainly Kotler's tools. The approach taken is meant to support the business analysis of mobile extranet services in Chapter 7.

2.3.1 Market Testing

After management is satisfied with functional and psychological performance, the product is ready to be put to a market test. The amount of market testing is influenced by the investment cost and risk on the other hand, and the time pressure and research cost on the other. High investment - high risk products, where the chance of failure is high, must be market tested. [17]

New technologies will normally undergo alpha testing (within the company) and beta testing (with outside customers). Beta testing often exposes unanticipated problems of safety and servicing and alerts the vendor to customer training and servicing reuirements. [17]

2.3.2 Pricing

Pricing a new product or service can be a very difficult task, especially if the service is radically new in the markets. Price is the marketing-mix element that produces revenue; the others produce costs. Price is also one of the most flexible elements: it can be changed quickly, unlike product features and channel commitments. Yet many companies do not handle pricing well. The most common mistakes are these: Pricing is too cost-oriented; price is not revised often enough to capitalize on market changes; price is set independent of the rest of the marketing mix rather than as an intrinsic element of market-positioning strategy; and price is not varied enough for different items, market segments, and purchase occasions. [17]

The basic pricing process suggested by [17] includes six steps. The steps are:

1. selecting the pricing objectives
2. determining demand
3. estimating costs
4. analysing competitors' costs, prices, offers
5. selecting a pricing method
6. selecting the final pricing

The fist step includes the decision on where the company wants to position the market offering. A company can pursue any of five major objectives through pricing survival, maximum current profit, maximum market share, maximum market skimming, or product-quality leadership.

Each price will lead to a different level of demand. The relation between alternative prices and the resulting current demand is captured in a demand curve. In the normal case, demand and price are inversely related: the higher the price, the lower the demand. There are several methods for measuring demand curves. These include price experiments, analysing past prices and quantities sold and market researches.

The third step, estimating cost is setting the floor on how low the prices can get. The company wants to charge a price that covers its cost of producing, distributing, and

selling the product, including a fair return for its effort and risk [17]. The costs are divided into fixed and variable. The next chapter deals with the issue.

Selecting a pricing method is the fifth stage of the process. There are several price setting methods. These include for example markup pricing, target-return pricing, value pricing etc.

The last step is setting the final price. There are several other considerations that must be taken into account at this stage. The company may use differential pricing. [27] suggests three different types of differential pricing:

- Personalised pricing: Sell to each user at a different price.
- Versioning: Offer a product line and let users choose the version of the product most appropriate for them.
- Group pricing: Set different prices for different groups of consumers, as in student discounts.

Management must also consider the reactions of other parties to the contemplated price. The considered questions include: will the sales force be willing to sell at that price? How will competitors react? Will the government intervene and prevent this price from being charged?

All these points must be taken into account when pricing the mobile extranet services. There are several problems with the WAP-based applications. One problem with the pricing of mobile extranet services is the determination of the added value to the customer. This is essential, when the pricing of the applications is planned. The question is how much is the customer willing to pay for mobility.

The current pricing methods could cause another problem. The new technology must be adjusted to the pricing scheme of the existing extranet services. Because the pricing of 'traditional' mobile services (i.e. the mobile phone calls, SMS services etc.) is different from the pricing of Internet services, it may cause problems for the customer to understand the pricing scheme of the new services. Traditionally, the pricing of the

SMS value added consumer services has been transaction-based. On the other hand, the mobile data calls have a time-based charging. Internet services rarely use volume-based pricing, most of the price schemes are based on a fixed fee.

Integrating the new mobile phone-based technology to the existing billing systems may also require reorganising from the service provider. These two technologies have previously been taken care of by different units in the company and are possibly using different billing systems. However, WAP technology has bee designed in such a way that it offers the tools for flexible pricing. The pricing problems have been tried to into account, when the protocols have been developed. Therefore, there should not be any technical problems in fitting WAP into different pricing schemes.

2.3.3 Estimating Costs and Profits

This task can be divided into two parts: on one hand, estimating the costs and profits of developing and producing a new service, and on the other, the costs for the service customer.

The companies producing a new service can use many financial measures to evaluate the merit of a new-product proposal. The simplest is break-even analysis, in which management estimates how much must be sold to break-even with the given price and cost structure. If management believes sales could easily reach the break-even number, it is likely to move the project into product development. [17]

The most complex method of estimating profit is risk analysis. That is, three estimates (optimistic, pessimistic, and most likely) are obtained for each uncertain variable affecting profitability under an assumed marketing environment and marketing strategy for the planning period. The computer simulates possible outcomes and computes rate-of-return probability distribution showing the range of possible rates of returns and their probabilities. [17]

Estimating the customers cost consists mainly of three elements: the purchase price of the service, cost of ownership and amount of time and resources the service requires

[1]. Sometimes estimating these costs, especially the two latter, can be difficult, but some kind of evaluation must be carried out. Knowing the customer's cost is an essential part of the marketing process of the new service. The method used in this study is return on investments (ROI). A simple example analysis on the case of different WAP-based solutions are presented.

2.3.4 Commercialisation

If the company goes ahead with commercialisation, it will face its largest costs to date. These costs include building the production and marketing. The essential points in commercialisation are [17]:

- Timing
- Geographic Strategy
- Target-Market Prospects
- Introductory Market Strategy

If the new service is using new technology, market entry timing is critical. A company finishing the product development faces three choices [17]:

1. First entry: There are risks if the service is rushed to market before it is thoroughly debugged, the product can acquire a flawed image.
2. Parallel entry: Two or more competitors time their entry to coincide each other. The market may pay more attention when two companies are advertising the new product.
3. Late entry: The company might delay its launch until after the competitor has entered. The competitor will have borne the cost of educating the market. The competitor's product may reveal faults the late entrant can avoid. The company can also learn the size of the market.

Geographic strategy refers to the decision whether to launch the new service in a single locality, a region, several regions, the national market, or the international market. Most will develop a planned market rollout over time. [17]

Within the rollout markets, the company must target its initial distribution and promotion to the best prospect groups. The framework to analyse the appropriate marketing strategy for a radical technology is presented in Figure 2. In this market-application matrix model, the customers and applications are the two dimensions, subdivided into whether they exist for the old technology or not [9].

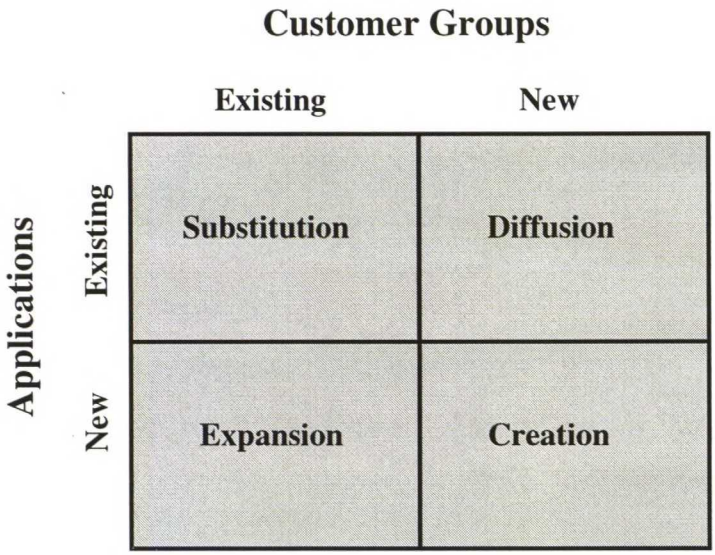


Figure 2. Market Applications Matrix [9]

If the new technology is displacing existing technology, either through submarkets or broadly, the sales will be coming from the Substitution quadrant. If the new technology is expanding the customer bas but for the same applications, the sales will come from the Diffusion quadrant. [9]

It is that positioning of new product should be based on the radicalness of the technology. If the technology is incremental, the proper positioning is the upper half of the matrix – the substitution and diffusion quadrants. On the other hand, if the technology is radical, the proper positioning is the lower part of the matrix – the expansion and creation quadrants. [9]

The radicalness of a technology can be determined for marketing purposed as a function of the amount of learning/behaviour change needed on the part of the customer

to use the technology product or service. If the new technology does not require any major change in customer behaviour or learning, then it is not a radical technological innovation in this context. [9]

The final commercialisation point, introductory market strategy, should answer to the question "how?" The company must develop an action plan for introducing the new product into the rollout markets. To co-ordinate the many activities involved in launching a new product, management can use network planning such as critical path scheduling (CPS).

3 Extranet Business Concept

3.1 Customer Problem

3.1.1 Communication

One of the major problems companies are facing currently, is communication. That is, the complexity of different relationships and communication channels are difficult to manage. This is a result of the current business trends. Partnerships, joint ventures, company networks, subcontracting and business-to-business commerce are becoming necessities in all fields of industry. Co-operation requires seamless communication between the different interest groups.

The problem of communication can be illustrated with a simple diagram (Figure 3).

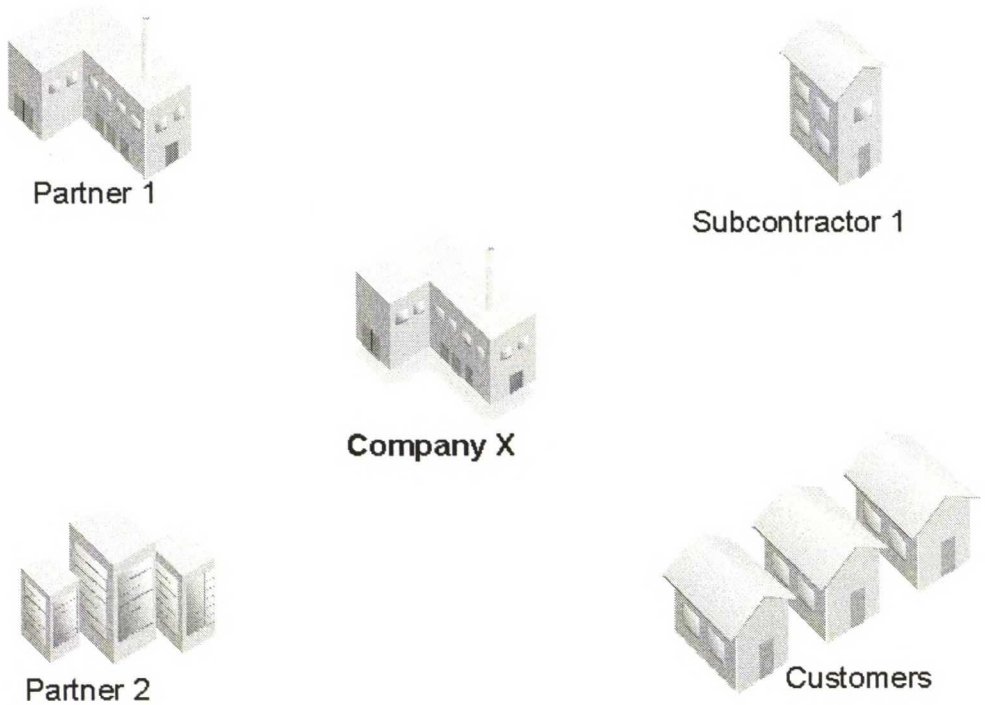


Figure 3. Intercompany Communication

In the example, Company X has customers, two partners and one subcontractor. Clearly, there is a need for the company to communicate with all these parties. In addition to this, it might be in the best interest to the Company X to for example Partner 1 and Partner 2 to be able to communicate to each other and customers might have a communication interface with Partner 1. Subcontractor 1 may also need a channel to Partner 1. The form of these communication channels does not need to be defined, they can be for example some mutual application (project management, document management etc.) or simply person-to-person communication. The possible services are discussed in Chapter 3.3. Now, the communication diagram looks like in Figure 4.

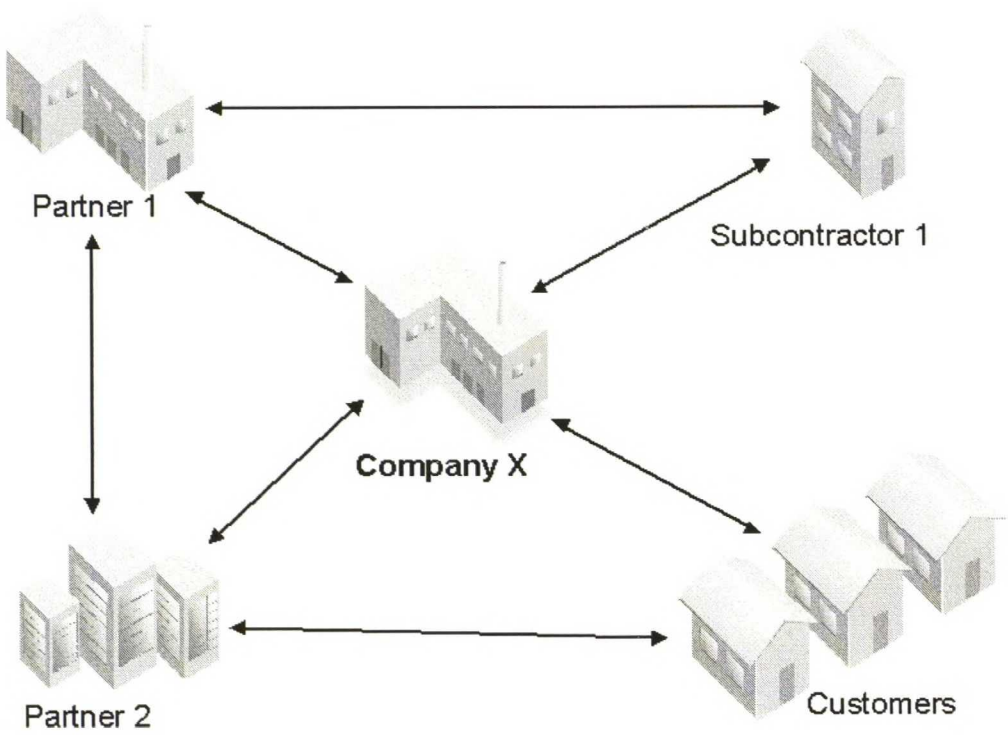


Figure 4. Intercompany Communication Channels

Figure 4 shows all the communication channels Company X needs for successful operation. The management of these channels must be controlled and the access of different parties to Company X's resources must be restricted. Technically, the management of these channels and the applications used by the different parties should be done under a single management entity. The complexity of the protocols and

technologies in the extranet communication solution may be too high for the company to cope with alone.

3.1.2 Security

Another major problem in intercompany communication is security. That is, the integrity, confidentiality and the availability of the transferred data must be guaranteed. If the simplified example from the previous chapter is continued, one way to describe the problem is illustrated in Figure 5.

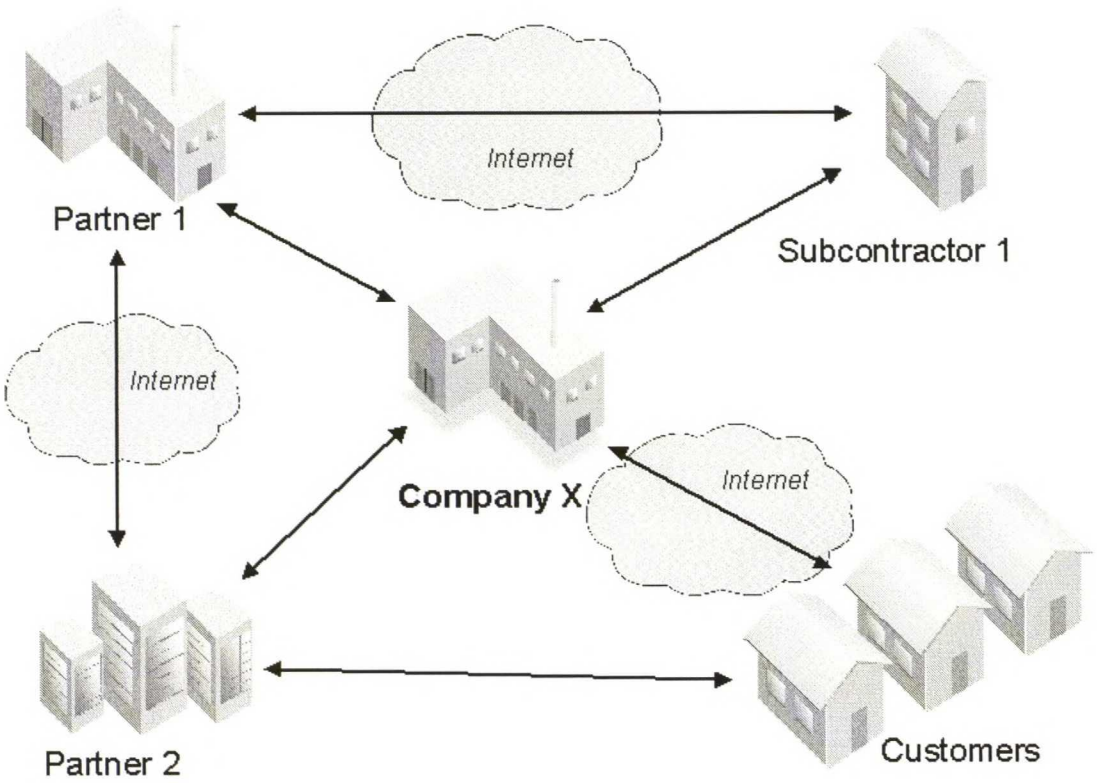


Figure 5. Intercompany Communication in Unsafe Networks

Many companies are communicating over Internet. The used applications are for example email and WWW. Even though IP -protocol offers a good common ground to build the communication on, the problem is obvious: how to guarantee the security of the communication? Internet protocols do not offer any degree of the security and the applications and services used in extranets would require strong authentication,

authorisation, data encryption and quality of service. There is no common single protocol or standard for enforcing security in Internet communication, but instead several different, competing protocols.

The extranet is useless without the ability to securely transmit sensitive data between intranets and authorised partners. The stronger the security measures, the more hardware and software resources are required to maintain an acceptable performance level. This balance between security levels and return of investment (ROI) and analysis should be part of the initial investigation before extranet development work begins. [30]

3.2 International Extranet Business Concept

According to a study by the GartnerGroup, extranets are expected to be the platform of choice for more than 80% of business-to-business E-commerce by the year 2001 [30]. The market for selling extranet services and solutions is growing rapidly. Both telecom carriers and internet service providers (ISP) are developing their services to crab a part of the market share.

The provision of extranet services, that is, the business in the scope of this study is selling a complete solution: the servers, data lines, platform for both the intranets and extranets of a company and partly also the applications offered in the extranets. The main emphasis, however, is in selling the network solution, meaning the secure connections and a way to manage the access to the extranet applications according to the company's security policy. Forming extranets means they must be reliable which is accomplished with the use of strong data encryption but they often are also dynamic in nature meaning quick response times from the service provider that creates the extranets [15].

The concept offers the customer a possibility to create secure extranets, to maintain them and dynamically update the partner network. The service may include elements like server and network maintenance, application development etc.

3.3 Extranet Services

There is a large variety of different services and applications that can be used in a company extranet. The services must be chosen carefully according to the company's needs. Large multinational companies have different needs for their extranets compared to small, localised firms.

A practical example of an extranet could be a large service provider company that has several resellers, like Sonera. The pricing of the services of a company like this is consisted of several different components and the prices change on daily basis. Therefore, the resellers would need an access to the pricing tools that use the pricing database of the company. An easy solution would be to build a web-based pricing tool and give an access to the resellers to use the tool. The same web page could also include the latest versions of product documents and other possible documentation needed by the reseller representatives. The network of resellers and the distribution of documents is much easier to manage with a single access point to everyone. If this reseller would have an access to the same pricing tool with a mobile phone, would it bring any added value? If the reseller representatives would get a notification of an update in the prices to his/her mobile phone, would that bring any added value? These are examples of the questions this study tries to find answers to.

Another example of an extranet service is a small software developer company that reports bugs and distributes software patches to its customers through its 'extranet'. The customers of the company get an access to the protected web page, where they can download new patches, view bug reports and input new bugs or development suggestions. The page should be configured dynamically according to the customers' licences. The added value compared to a static web page with access for everyone or compared to some other means of handling the patches and the bug reporting is obvious. If the customers could get bug reports automatically to their mobile devices and leave bug reports with a mobile phone, what would be the added value of the service?

The possible areas of services in extranet are presented in this chapter on a general level. Finally, the idea is to combine these services, or the ones of them used by the company, to a business-to-business portal, a common access point for all the extranet applications.

3.3.1 Information Delivery Services

Information delivery services can also be found from the Internet web sites. In extranets, the information can typically be more confidential as it is protected from unauthorised access [33]. Typically, in this type of service the interaction between the parties is kept to minimum and the ability to find the right information is emphasised.

The information delivered can be push or pull –type of content. It can be for example daily email of news or statistical data from some service. The information may be in a directory, or it is fetched from a database. Possible delivered information can be documents, news, logistics information, statistics, etc. The amount of transferred information is fairly low in information delivery services.

The security is fairly easy to implement on these applications. All that is needed is simple access control and authorisation to the documents. No high-level security features are needed.

3.3.2 Database Query Services

Sometimes the data the business partner needs to access is more finely grained than just simple information documents. There might be a need to make for example Boolean searches to the data and create reports from it. The databases are associated to many different functions performed in a company, such as order processing and logistics management [33]. The storages are usually relational database management systems (RDBMSs). The language used to access the data is Structured Query Language (SQL) [11] and there are several standards that can be used on the top of the database, for example Open Database Connectivity (ODBC) or Java Database connectivity (JDBC).

Possible database query services are for example contact information and logistics information etc. On average, the level of interaction is higher in this type of service than it is in simple information delivery. However, the amount of transferred data is approximately the same as in information delivery services.

The query applications must have high-level security features. Because all the data is usually in the same database, the client application must authorise the user to the correct information. There are several different security mechanisms to implement secure database access client applications. For example, selective replication, access control in middleware or the access control mechanisms can be applied to the back-end database systems.

3.3.3 Customer Services

Customer service applications support reporting of failures, bugs, abnormal operation, billing information, on-line helpdesk and customer satisfaction surveys. These applications may support free-formed communication, like for example e-mail, or guided interaction like web forms. The authentication can be done for example by asking some product -related information like the serial number or customer id. If confidential customer information is exchanged, the traffic must by highly secured. Customer satisfaction surveys are an example of application that has no high requirements for security. They are usually public and voluntary.

The amount of transferred data is usually quite small in customer service applications. Security level is fairly high, depending, however, on the nature of the customer service and transferred data.

3.3.4 Document Management

Document management across organisation boundaries can be a difficult task. Maintaining access controls and extranet replication properly adds to the complexity of traditional document management. In addition to version and integrity control,

metadata management, renditions, compound documents, interest profiles and searches, all extranet-related requirements make it more difficult to build working systems. [33]

Despite of the complexity associated with document management, it is necessary with cross-organisational projects as well as in all other projects [33]. The level of security can be said to be extremely high in cross-organisational product management. All parties involved must be authenticated and authorised and the traffic must be encrypted.

Both the level of interactivity and amount of transferred data are high in document management applications.

3.3.5 Discussion Groups and News Services

There is not much difference between news services and information delivery services. News services support threaded responses and access control. Attachments, like binary files, are usually also supported. The level of interaction is higher in discussion group and news services. The content is created by the users, while in information delivery services the content is created by a third party and broadcasted to the users by the application.

Different on-line discussion groups can also be included in this service area, like Internet Relay Chat (IRC) groups or web-based chat clients. Recently, these programs have gained more success in the business world, because they are an easy and fast way to communicate with simple text-based client.

The discussion groups and news services usually use Network News Transfer Protocol (NNTP) or Hypertext Transfer Protocol (HTTP). The amount of transferred data is low (can vary a lot depending on the applications) and the required security level is high. Interactivity between the users and the service is an essential part of the discussion group and news applications.

3.3.6 E-commerce

E-commerce is a wide and ambiguous concept. It can be divided into two major classes: business-to-business and business-to-consumer systems. As this study deals with only extranets, which are applied in business-to-business environments, here this concept refers to any kind of business-to-business trading over the network, whether it is ordering a spare part or large network infrastructure. E-commerce is a combination of multiform elements like business processes, interest groups, and networks. The goal of using E-commerce is to bind and integrate these factors together and to make business activities as efficient as possible [18].

In the extranet e-commerce, the requirements for applications are eased through pre-negotiated contracts on invoicing and the support for wide-scale of payment methods is unnecessary [3]. However, the requirements for the security of the e-commerce applications are very high. Commerce usually requires the transferring of money transactions over a network and this information is very vulnerable. All parties involved must also be strongly authenticated. The major barrier to conducting on-line business transactions in the past has been concerns about the safety of the user's financial information [3].

In extranet environment, the e-commerce applications are targeted to wholesale suppliers, who buy products in great numbers at once. The products are usually such that the buyer does not need to see or test it in advance, or the buyer has already accepted the product. The amount of transferred data is fairly low, if only the order information is exchanged. However, the required interaction ranges from low to very high. For example, the products ordered can be very complicated, modular and require several different definition steps, like spare parts to complicated machines. On the other hand, they can be standardised parts that can be ordered simply by the serial number of the product.

3.3.7 Business-to-Business Portal

Portal is fairly new term, meaning an anchor site for different services. That is, portal is a collection of links or applications that can be used for different purposes. In consumer world, most Internet Service Providers (ISPs) offer their own portal service for the customers and for others, too. In business world the term is not so widely used. The term 'enterprise portal' has also been used in some contexts. The idea is to combine the offered services in one company's extranet into a common gateway for all extranet users. So, portal is not an application, but a collection of applications. There can be some intelligence and 'application' –like features in portal itself, for example encryption, authentication and authorisation mechanisms. Figure 6 illustrates the idea.

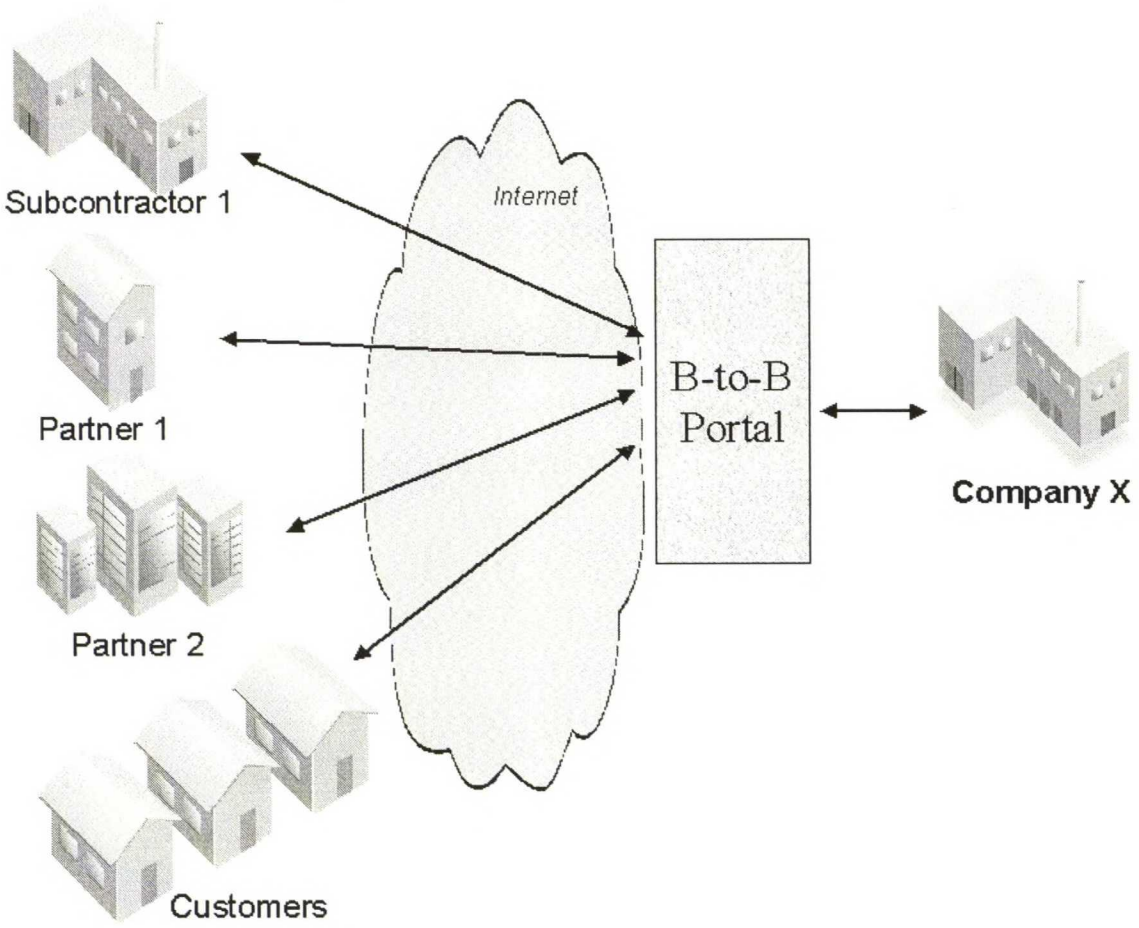


Figure 6. Business-to-Business Portal

The portal offers a common interface for all the communication between the company and other parties. Traffic in the Internet is always encrypted and the users of the portal

are strongly authenticated and then authorised to use the right applications. All the proper applications and documents are shown with a single-sign-on or alternatively, only authorisation is offered and each application will separately authenticate the user. Either way, the communication channels are more manageable, when there is a single access point for all the parties.

Setting up a portal like this requires in many cases much reorganising from the companies. They have to gather all their communication access points into one place and that can be a difficult task, especially in larger multinational companies with numerous different interest groups. Therefore implementing this simple idea is not technically easy in practise. Chapter 3.4 presents one solution to the problem.

3.3.8 Summary of Extranet Services

Table 2 summarises the most important quantities of previously presented extranet services. The required level of security, amount of transferred data and level of interaction is estimated for each service. The grades are low (L), medium (M) and high (H).

Table 2. Extranet Services Summary

Service	Level of Security	Amount of Transferred Data	Level of Interaction
Information Delivery Services	L	M	L
Database Query Services	M	L	M
Customer Services	H	L	M
Document Management	H	H	H
Discussion Groups and News Services	M	M	M
E-commerce	H	M	H

3.4 Extranet Infrastructure: Case Sonera Solutions

This chapter introduces one possibility to implement an extranet service. The solution is based on Sonera Security Foundation [15] concept, which presents a complete security service package for corporate networks. Figure 7 shows the technical solution at a system level.

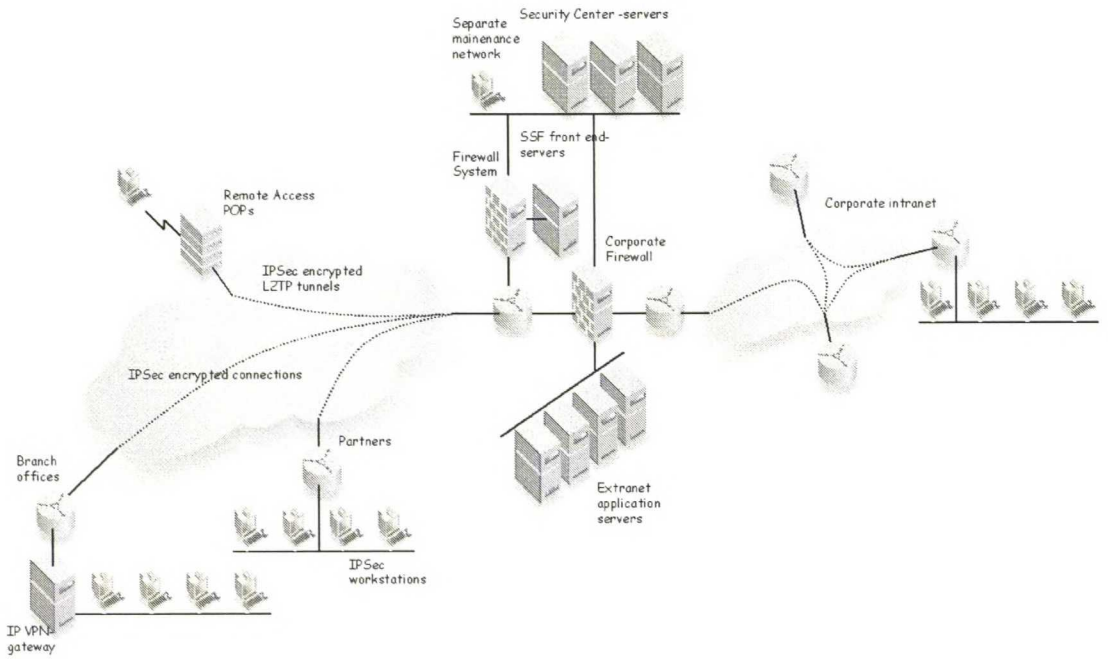


Figure 7. Extranet Infrastructure Example

The example solution creates a demilitarized zone (DMZ) between the corporate intranet and insecure network. The encryption and the access control are carried out in this zone, it includes the application servers and the firewall systems. The security is enforced by using VPN technology and the encrypted tunnels are created with IPSec [12, 13, 14].

The heart of whole Sonera Security Foundation is Sonera implementation of LDAP directory to which different security service components connect through LDAP protocol [34] Huge amount of security information is stored in the directory: firewall rules, one-time password system users, available services, company and user profiles. This all is implemented in one logical directory and information stored is used everywhere, also for value-added services such as reporting. [15]

Extranet application platforms can be located inside corporate networks and partners access them through the network. Usually, however, this is against the security policy enforced in the company that offers the services or applications. Therefore, to fully support the extranet concept and security policies of involved companies, Sonera offers as part of Sonera Security Foundation application server management in Sonera Security Center. [15]

3.4.1 Key Roles

The following key roles can be identified from the architecture:

- Technology vendors (F-Secure, Cisco, Sun etc.)
- Service integrators (Sonera)
- Service providers (Sonera and its subsidiaries abroad)

In the value chain Sonera works as a service provider. The service provider uses technologies from different vendors to create a managed service to the customer. The service provider manages the customer interface and offers added value to the technology by providing services like server maintenance, reporting, logging and customer services. The technology components and the hardware are acquired from technology vendors. The key partner in the Sonera Security Foundation concept is F-Secure (former Data Fellows Corporation). F-Secure provides the security technology (IPsec implementation and VPN software). [15] The concept also supports security solutions from other vendors, such as Check Point Software Technologies Ltd., Cisco Systems Inc., Teamware Group etc. [15]

Sonera also carries out the service integration. The development of additional software components and implementations can also be outsourced, but in this case they are done in-house. These components include the LDAP directory implementation and integration software, namely the end-user view to the service, the graphical user interface (GUI).

3.5 Current Market Trends

This chapter gives a short insight on how the markets are evolving currently and what are the business trends that can be seen in electronic business-to-business markets. Several market researches and reports are used as the basis for the discussion.

There are four types of service providers in electronic business-to-business commerce markets [25]:

- niche players
- integrated, multi-niche players
- single supplier, total solution service providers
- partnership-based, total solution service providers

In new markets, brand (and therefore significant marketing power) is everything. Without this, even the most innovative and useful of offerings can go unnoticed. Partnerships between new market entrants and existing providers will be a vital way of creating channels to market; without partnerships, new and smaller suppliers risk becoming lost in the crowd. [25]

[22] evaluates that through 2002/03, procurement operations will be segmented (production, MRO, commodity) and automated via numerous EC tools (increasingly integrating e-forms, workflow, content comparison/aggregation, payment, EDI/XML, etc.) and providers (sourcing negotiation, application, and integration services, plus forming buying/selling communities). Improvements will appear as "customerization" facilities, enabling organizational, functional, and personal specificity.

Wireless applications will also play an important role in the future business-to-business applications. [7] states that enterprises that do not mobilise goods and services with wireless technology will lack a significant competitive advantage in the next five years, especially in the context of an “electronic” economy.

4 WAP Technology Concept

4.1 Background

Most of the technology developed for the Internet has been designed for desktop and larger computers and medium to high bandwidth, generally reliable data networks. Mass-market, hand-held wireless devices present a more constrained computing environment compared to desktop computers. Because of fundamental limitations of power and form-factor, mass-market handheld devices tend to have several restrictions because of their smaller size and physical constraints. These restrictions include less memory and different input devices. [38]

Similarly, wireless data networks present a more constrained communication environment compared to wired networks. Because of fundamental limitations of power, available spectrum, and mobility, wireless data networks tend to have less bandwidth and more latency. In addition, the connections in wireless networks are usually less stabile and the availability cannot be predicted as well as in wired networks. [38]

WAP protocol has been developed to address these very problems. The requirements of the WAP Forum architecture are to define a layered, scalable and extensible architecture that works securely on as many wireless networks as possible. [38]

The main point in the architecture, from the end-user point of view, is that it allows the direct interfacing between a TCP/IP medium and a mobile station medium and that it specifies an application environment including a microbrowser, scripting, telephony value-added services, and content formats. The applications should be scalable to make the best use of available display and network data transport capabilities across terminal types. Services should be created for single-line text displays in standard digital mobile phones [36].

4.2 WAP Architecture Overview

4.2.1 Programming Model

The WAP programming model (Figure 8) is similar to the WWW programming model. This provides several benefits to the application developer community, including a familiar programming model, a proven architecture, and the ability to leverage existing tools (eg, Web servers, XML tools, etc.). Optimisations and extensions have been made in order to match the characteristics of the wireless environment. Wherever possible, existing standards have been adopted or have been used as the starting point for the WAP technology. [38]

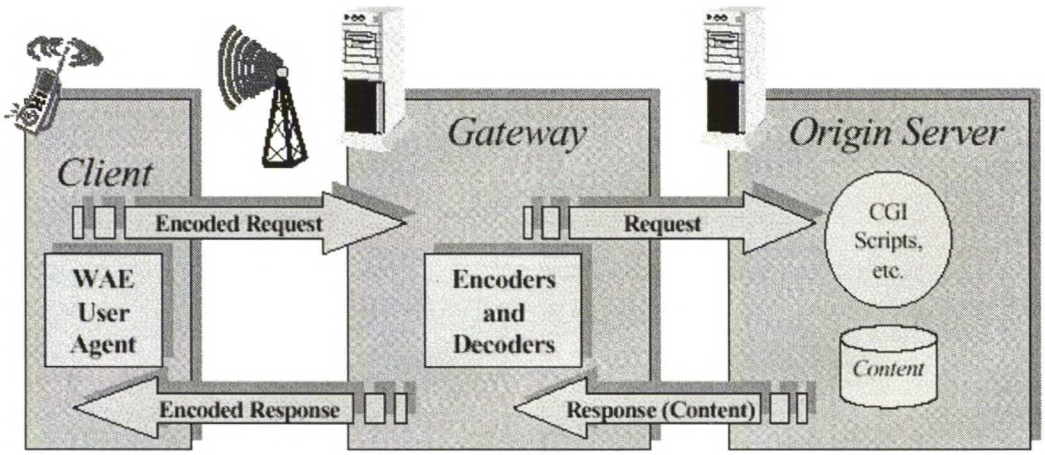


Figure 8. WAP Programming Model

WAP defines a set of standard components that enable communication between mobile terminals and network servers. It uses a standard naming model, namely WWW – standard URLs (Uniform Resource Locators). They are used to identify WAP content origin servers. All WAP content is given a specific type consistent with WWW typing. This allows WAP user agents to correctly process the content based on its type. WAP content formats are based on WWW technology and include display markup, calendar information, electronic business card objects, images and scripting language. WAP provides standard communication protocols that enable the communication of browser requests from the mobile terminal to the network web server. [38]

The WAP content types and protocols have been optimised for mass market, hand-held wireless devices. WAP utilises proxy technology to connect between the wireless domain and the WWW. While the nominal use of WAP will include a web server, WAP proxy (WAP gateway) and WAP client, the WAP architecture can quite easily support other configurations. It is possible to create an origin server that includes the WAP proxy functionality. Such a server might be used to facilitate end-to-end security solutions, or applications that require better access control or a guarantee of responsiveness, e.g., WTA. [38]

4.3 Components of the WAP Architecture

The WAP architecture provides a scaleable and extensible environment for application development for mobile communication devices. This is achieved through a layered design of the entire protocol stack (Figure 9). Each of the layers of the architecture is accessible by the layers above, as well as by other services and applications. [38]

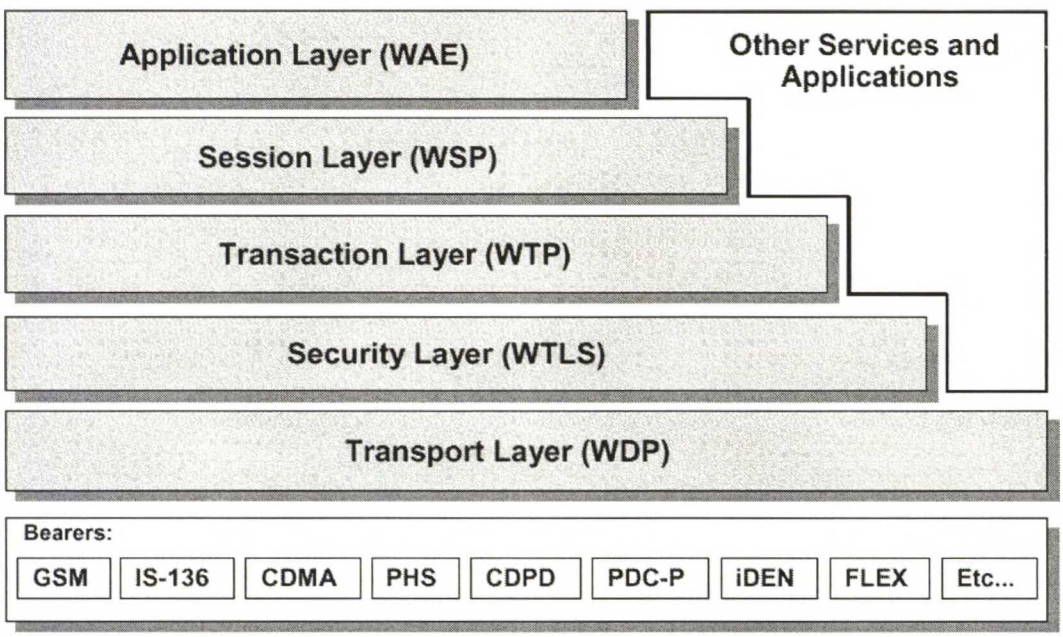


Figure 9. WAP Protocols [38]

When comparing the protocol stack with OSI model WAP implements all OSI layers, but the layer ordering and naming is different. The layering of protocols and their

functions are not similar to that of ISO OSI Reference Model. The biggest difference is that WAP security layer is placed below the transaction and session layers. [16]

The WAP layered architecture enables other services and applications to utilise the features of the WAP stack through a set of well-defined interfaces. External applications may access the session, transaction, security and transport layers directly. The following sections provide a description of the various elements of the protocol stack architecture. [38]. The emphasis is put on the parts that have significance bearing in mind the subject of this thesis. This means that the parts examined more carefully are the application environment and the security protocols.

4.3.1 Wireless Application Environment (WAE)

The Wireless Application Environment (WAE) is a general-purpose application environment based on a combination of World Wide Web (WWW) and Mobile Telephony technologies. [38]

The WAE architecture includes all elements of the WAP architecture related to application specification and execution. At this point, the WAE architecture is predominately focused on the client-side aspects of WAP's system architecture, namely items relating to user agents. Specifically, the WAE architecture is defined primarily in terms of networking schemes, content formats, programming languages and shared services. Interfaces are not standardised and are specific to a particular implementation. [36] Figure 10 presents a model of the WAE components and their relations to the protocol stack.

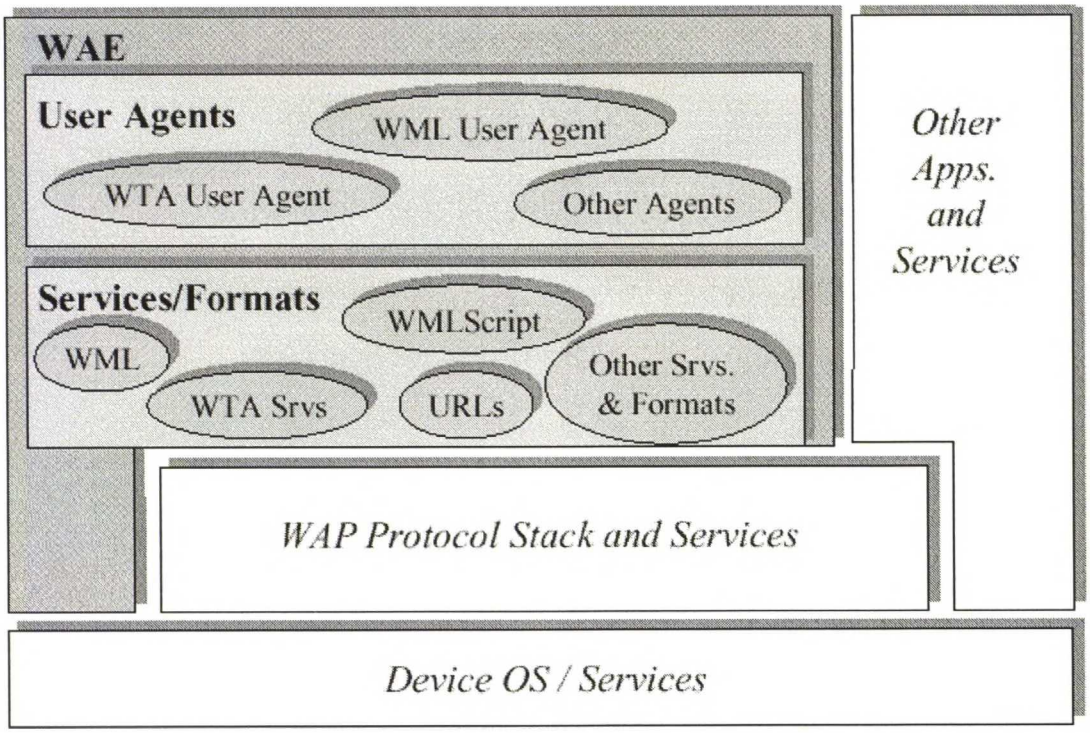


Figure 10. WAE Client Components [36]

4.3.1.1 Wireless Markup Language (WML)

WML is an XML-based (Extensible Markup Language) language, or, more precisely, WML is specified as an XML document type. [6] In a nutshell, WML is a tagged language, much like HTML, where individual language elements are delineated by case-sensitive, lower-case tags that are enclosed in angle brackets. It's common to use the terms "element" and "tag" interchangeably when discussing WML programs. [21]

The basic WAP application metaphor is a deck of cards, where each deck is essentially a program (more accurately, a document with a unique URL, delivered from a server). Each card is a single visible user interaction such as a choice list or a data entry form. Syntactically, you usually put the non-visible portion of the card, the part that contains executable elements, first, followed by the visible content [21].

WML and its supporting environment were designed with certain small narrow-band device constraints in mind including small displays, limited user-input facilities, narrow band network connections, limited memory resources and limited computational resources. Given the wide and varying range of terminals targeted by WAP, considerable effort was put into the proper distribution of presentation responsibility between the author and the browser implementation. [36]

WML includes a variety of technologies to optimise communication on a narrow-band device. This includes the ability to specify multiple user interactions (cards) in one network transfer (a deck). It also includes a variety of state management facilities that minimise the need for origin server requests.

WML supports text with different emphasis elements and simple styling options. With WML, it is possible to create text entries and option selection in the similar manner as in HTML forms. WML also includes task invocation controls. That is, when activated, these controls initiate a navigation or history management task such as traversing a link to another card or popping the current card off the history stack. [36] Thus WML allows several navigation mechanisms using URLs. WML's document character set is Unicode [31]. This enables the presentation of most languages and dialects. WML's abstract specification of layout and presentation enables terminal and device vendors to control the MMI design for their particular products. [36]

4.3.1.2 WMLScript

WMLScript is a lightweight procedural scripting language loosely based on a subset of the JavaScript WWW scripting language. It enhances the standard browsing and presentation facilities of WML with behavioural capabilities, supports more advanced UI behaviour, adds intelligence to the client, provides a convenient mechanism to access the device and its peripherals, and reduces the need for round-trips to the origin server. [36]

4.3.1.3 WAE Content Formats

WAE includes a set of agreed upon content formats that facilitate interoperable data exchange. The method of exchange depends on the data and the targeted WAE user agents. [36]

The content formats include the following [36, 37]:

- encoded WML
- encoded WMLScript
- images (PNG and Wireless BitMap Format (WBMB))
- multipart messages
- user-agent specific formats

4.3.1.4 Wireless Telephony Application (WTA)

WTA is a collection of telephony specific extensions for call and feature control mechanisms that make advanced Mobile Network Services available to authors and end-users. WTA merges the features and services of data networks with the services of voice networks. It introduces mechanisms that ensure secure access to important resources within mobile devices. The WTA framework allows real-time processing of events important to the end-user while browsing [44]. The specific use of WTA is still unclear, because there are no working implementations.

4.3.1.5 Security Features

WAE leverages WTLS where services require authenticated and/or secure exchanges. In addition, both WML and WMLScript include access control constructs that communicate to the client URL-based access restrictions. In particular, the constructs allow the authors of WML decks and WMLScript to grant public access to the content (i.e., the deck or script can be referenced from other content) or restrict access to the content to set of "trusted" decks or scripts. [36]

The operator is assumed to have control as to what resources are be made accessible to any anonymous or third party content in both the mobile network and the client. The integrity of the mobile network and the client are enforced because of a restricted WTA

content delivery. In particular, content with privileged WTA services can only be executed when it is delivered to the WTA user agent through a dedicated WTA port running WTLS protocols. This allows network operators to use standard network security elements to protect their networks. For example, origin servers, delivering content, can be identified, by the operator, as either trusted WTA content servers that are under the control of the device's operator, or as untrusted third party content servers, which may include any public origin server on the Internet. Network operators can then use standard firewall technologies to regulate access to a mobile's ports. Port access, can then be used to determine the credentials given to content, which determines its access privileges to WTA services in both the network and the client. [36]

4.3.2 Wireless Session Protocol (WSP)

The Wireless Session Protocol (WSP) provides the application layer of WAP with a consistent interface for two session services. The first is a connection-oriented service that operates above the transaction layer protocol WTP. The second is a connectionless service that operates above a secure or non-secure datagram service (WDP). In other words, the corespondent to WSP in WWW world is HTTP. The core of the WSP design is a binary form of HTTP. [38, 42]

4.3.3 Wireless Transaction Protocol (WTP)

The Wireless Transaction Protocol (WTP) runs on top of a datagram service and provides as a light-weight transaction-oriented protocol that is suitable for implementation in "thin" clients (mobile stations). WTP operates over secure or non-secure wireless datagram networks. It provides three classes of transaction service: unreliable one-way requests, reliable one-way and reliable two-way request reply transactions. [38]

4.3.4 Wireless Transport Layer Security (WTLS)

The security layer protocol in the WAP architecture is called the Wireless Transport Layer Security. The WTLS layer is modular and whether it is used or not depends on the required security level of the given application and the network that is used [33]. For example, if the network is secure and provides privacy at a lower level, this feature can be disabled from the WTLS. WTLS provides a secure transport service interface that preserves the transport service interface below it. In addition, WTLS provides an interface for managing secure connections [33].

WTLS is a security protocol-based upon the industry-standard Transport Layer Security (TLS) protocol, formerly known as Secure Sockets Layer (SSL). WTLS is intended for use with the WAP transport protocols and has been optimised for use over narrow-band communication channels. WTLS provides data integrity, privacy, authentication and denial-of-service protection. WTLS may also be used for secure communication between terminals, e.g. for authentication of electronic business card exchange.

The features mentioned above are implemented with four basic cryptographic operations (examples of possible algorithms to be used are in brackets) [45]:

- Digital signing with one way hash functions (SHA-1, MD5)
- Stream cipher encryption (RC5, DES, 3DES, IDEA)
- Block cipher encryption (RC5, DES, 3DES, IDEA)
- Public key encryption (RSA, Diffie-Hellman)

4.3.5 Wireless Datagram Protocol (WDP)

The Transport layer protocol in the WAP architecture is referred to as the Wireless Datagram Protocol (WDP). The WDP layer operates above the data capable bearer services supported by the various network types. As a general transport service, WDP offers a consistent service to the upper layer protocols of WAP and communicate transparently over one of the available bearer services. [38]

4.3.6 Bearers

The WAP protocols are designed to operate over a variety of different bearer services, including short message, circuit-switched data, and packet data. The bearers offer differing levels of quality of service with respect to throughput, error rate, and delays. The WAP protocols are designed to compensate for or tolerate these varying level of service. [38]

The list of most currently available bearers can be seen from the figure 2. GSM bearers include for example GSM SMS, circuit-switched data, USSD and GSM Cell Broadcast [41]. In the future, when the mobile technologies develop, more bearers can be added to the stack according to the needs of the mobile users.

4.3.7 Other Services and Applications

The WAP layered architecture enables other services and applications to utilise the features of the WAP stack through a set of well-defined interfaces. External applications may access the session, transaction, security and transport layers directly. This allows the WAP stack to be used for applications and services not currently specified by WAP, but deemed to be valuable for the wireless market. For example, applications, such as electronic mail, calendar, phone book, notepad, and electronic commerce, or services, such as white and yellow pages, may be developed to use the WAP protocols. [38]

4.4 International Mobility

The WAE architecture is designed to support mobile terminals and network applications using a variety of languages and character sets. This work is collectively described as internationalisation (referred to as I18N). It is a design goal of WAE to be fully global in its nature in that it supports any language. [36]

Because WAP is created to work on as many different bearers as possible, it means that the WAP services can be used globally. There are constraints, of course. The same end-

user device cannot be used in different networks. True global mobility would require a "chameleon" mobile device that could adopt itself to the standards of its current bearer network. At the moment there are mobile phones that can use two or even three different networks. Especially this is important on the American markets, where different mobile networks are still competing and covering different areas. For example Nokia is planning to introduce a WAP phone model 7160 that works on three different networks: AMPS, TDMA 800 and TDMA 1900 [35]. This device could be used quite widely in North America, but for example in Europe, it would be useless. So, it is important to bear in mind that when the concept of international mobility is discussed, it refers to the mobility inside one network. Fortunately, the situation is quite clear in Europe where GSM is the only digital wireless network.

4.5 WAP Services

WAP can be considered as a platform that offers data carrying services for different applications. However, the constraints of the network, the end-user devices and the protocols must be considered when analysing the possible services on WAP platform. If we think about the common Internet services, we can easily see what WAP can be used for. These include:

- Text-based browsing services (simple pictures included)
- E-mail
- Transaction processing

Some common Internet applications like multimedia or broadcast are not possible with WAP. The main reason is the amount of transferred data and the other are the constraints of the end-user device. However, as the mobile networks develop (see Appendix I), the performance of the possible applications and the amount of available bandwidth for data traffic increase.

WAP is designed for the key applications used by corporate customers over mobile Internet and in intranets. These are e-mail, web access and database access. Some

tailored services for WAP are also possible, for example different telephony applications or service management applications. Services like this, relating to the subject of this thesis, are discussed in section 5.

4.6 Added Value

4.6.1 General

This chapter discusses the added value that WAP protocol stack actually brings to the existing technologies and applications. This question can be tackled from several points of view: the end-users, service providers, equipment manufacturers, developers and content providers. In this thesis, the main interests lie on the first two groups: the end-users and service providers.

The added value of WAP technology for end-users can be easily argued. It is no doubt that the services will provide a new level of mobility for corporate customers. The usage of services is easy, because the model is old, familiar browser model and the services are basically the same type as in the WWW. WAP end-user device is more light-weight to carry than a laptop and the services are more accessible, no modems or additional software is required. As the web has created new markets and brought IT-based services and applications to the masses, so WAP should do in the mobile phone market [28]. And as the mobile phones and the networks develop, the WAP is designed in such a way that it can offer more quality of service according to the technology, i.e. when there are more bandwidth available, it is used.

The added value for the service providers can also be argued. They can add a large amount of information, content and functions accessible by their service, and possibly gain a competitive advantage over other providers that do not offer WAP services. It also allows an easier method to communicate with customers, and may make it easier for customers to find out information about the service to which they subscribe (such as online bill viewing/paying, ability to switch service plans themselves, new tariffs, etc.).

In the long term, this may even allow for a reduction in the number of actual customer service employees per customer. [28]

Also, running web-based applications over the network will make the rolling out of new intelligent network applications easier, as they only have to be deployed as WAP-based Web applications. [28]

4.6.2 WAP versus Short Message Service (SMS)

The title of this chapter is a little misguiding, because WAP and SMS are not necessarily cancelling out each other. SMS is one possible bearer of WAP applications. The purpose of this chapter is to discuss the added value of WAP applications to current SMS services.

SMS message length is limited, 160 characters, and this message is sent on the GSM control signalling channel. The maximum length of this message cannot be changed, even though there was more bandwidth available. WAP is a technology independent protocol stack. The applications running on it can use the available bandwidth more effectively. For example, if GSM data is used as a bearer, the WAP applications can use the maximum data rate of 14.4 kbit/s. Same applications run also on SMS bearer, but naturally more ineffectively.

Most SMS services currently offered in Finland use the following format: a service specific message is sent to a number where the application is run and the answer is sent back to the client. The use of this service requires that the service specific message and the number it should be sent to are known by the user. WAP offers significant added value to these applications, as no numbers or codes must be remembered. The user can *browse* to the service he/she wants to use through the service portal offered by the service provider.

For the service providers, the development of WAP application resembles more the development of WWW applications than SMS applications. SMS has a technology of its own and requires more specific knowledge of the GSM network infrastructure.

WAP applications are simpler to develop and derive from the existing web applications.

4.7 End-user devices

Roughly, the currently available WAP end-user devices can be divided into two different classes: phones and personal digital assistants. The basic difference between these two is that PDA is a separate device without any telephony capabilities. It requires a compatible phone to use the PDA for WAP services. The devices also have some substantial differences in their displays and input devices (i.e. the keyboard), but these features can differ depending on the manufacturer.

The problem with different end-user devices is that the applications they are capable of are not the same. It is naturally clear that a PDA with a large display, a keyboard and with larger memory can do more than a phone with very small display and a limited input devices. WAP allows the browser display to be of any type, of any size and with all kinds of features. The bottom line is that this is both good and bad. Some type of categorisation according to the end-user device's capabilities may be necessary. These features will be included in the version 1.2 of WAP protocol.

4.7.1 Phones

Currently, there are no WAP enabled phones in the markets. Most of the manufacturers have announced that they will bring products to the markets in the near future. Nokia announced in the spring 1999 that its WAP phone 7110 will be available during summer 1999, but the deployment was postponed due to technical issues.

4.7.2 Personal Digital Assistants (PDAs)

Smart handsets combine elements of traditional voice technology with standard operating system-based computer-based systems, which move the terminals one step nearer to the ubiquitous compact multi-mode multimedia terminal. Some companies use the terms media handsets and media phones. [26]

Ericsson has already launched its 'mobile companion', MC 218. It works together with most of Ericsson's mobile phones and includes a WAP microbrowser. The handset contains EPOC operating system and it communicates with infrared link to the used phone. [8]

4.8 Future of WAP

The future of WAP technology seems to be a guaranteed success story. It brings the Internet to mobile devices and does this in a way that every interest group benefits. All the biggest companies in the business support the standard and also use substantial amounts of money to market and develop the standards, the devices and the services.

WAP is not dependent on the technology underneath it so it will work in the handsets of the next generation, too. Due to necessary upgrade in technology by both the mobile telco and the user (with the need for a new handset), it will be some time before the actual services see levels of penetration approaching that expected for SMS by the end of 1999.

WAP services should grow in popularity beyond 2001, by which time there is likely to be a large installed base of WAP-compatible handsets and much web-based content available in the Wireless Application Protocol specifications. [28]

When the multimedia capabilities of the end-user devices and the bandwidth of the networks develop, WAP is able to support these features and offers and excellent platform for the mobile multimedia applications in the future.

Version 1.2 of the WAP protocol should be available by the end of 1999, and it will contain at least the following features [23]:

- Push-services
- Improved security features (e.g. certificate-based authentication)
- Handset feature determination

These are all very important features, when thinking about the extranet applications and business-to-business environment, as will be shown in the following chapters.

5 WAP-based Extranet Services

5.1 Introduction

This chapter discusses from the end-users point of view the services that could be offered as wireless in extranet environment. If Table 2 and the possible WAP services in Chapter 4.5 are examined, it is clearly see, what services are out of question in wireless environment. The following applications have such a nature that with some restrictions, wireless version of them could be implemented:

- Information Delivery Services
- Database Query Services
- Customer Service
- Discussion Groups and News Services
- E-commerce

All these do not require large amount of transferred data to be functional and the level of interaction is low or medium (except in e-commerce, but that point is discussed later).

In addition to these five, the service management functions could be implemented in a wireless environment. That is, the management and allocation of passwords and users, starting and closing certain applications, logging etc. could be carried out with a mobile device. There are also possible new services that the mobile devices make possible. These are also separately discussed.

These different services are presented in the next chapters and in the end, they are all combined together by outlining a concept of wireless portal. Finally, an example of the end-user view to a portal is illustrated.

5.2 Possible WAP Services

5.2.1 Information Delivery Services

Information delivery services fit easily and naturally to WAP environment. Both push and pull-type of information delivery can be implemented. The user can either get for example important news to his mobile device or he/she can browse the new information on a server. There are already several different consumer services available and the logic in business environment is exactly the same as in for example stock exchange information delivery services.

The benefit of mobility in these kinds of services would be the efficiency and the faster access to the information. For example notifying salesmen about changes in pricing information on the road with a mobile phone is more convenient and faster than setting up an Internet connection with a laptop or trying to find a fixed connection somewhere. Information delivery is also considered more secure in the wireless networks. For example, distributing passwords to a mobile phone is more secure than distributing them unencrypted with email.

5.2.2 Database Query Services

Database query services are on a higher level of complexity than simple information delivery. The line between these two is blurry, but basically database queries offer a possibility to make advanced searches to the data. In other words, the level of interaction is higher. This sets some restrictions to the mobile database query applications. First of all, the search criteria cannot be too complicated. If there are tens of different fields that can be used as criteria in a search, the user interface in the mobile device becomes too clumsy. Secondly, the fetched data amounts cannot be too large. For example, if the queries are made into a very extensive database of large entities, e.g. a document database, the search may return tens of answers and the end-user device may not be able to show all the relevant information. The security features of application like this require also some extra attention.

The benefit of mobility in this case is much the same as with information delivery services. Faster access to the database is possible with a mobile client. Mobile workers that need to access the information in the database from the road get a more convenient way to connect to the services.

5.2.3 Customer Services

WAP offers and excellent way to implement flexible and fast customer service applications. Feedback forms, bug reporting, FAQ lists or help-desk services can be transferred to mobile devices to some extend. Naturally, these services must be quite simple and cannot offer a high level of interaction.

Mobility in customer service applications offers added value, when the response times are required to be short, for example fault management of some time-critical device in a factory. Mobility would shorten the response time from both the customer's and the service provider's side. This point can be illustrated with a simple example: the control software in an automated factory breaks down in the middle of the night. The responsible maintenance person gets automatically a notification to his/her mobile device at home. Subsequently, he can immediately contact the device vendor's customer service site with the mobile phone. The message is sent from the site to the vendor's nearest repair person, will go to site and take care of the problem and the down time of the time-critical system is as short as possible.

5.2.4 Discussion Groups and News Services

Discussion groups and news services can be implemented in mobile environment, with some reservations. There cannot be too much transferred information and the user interface must have a suitable form to be able to show the required information. For example, chat services are very much possible, no much information is transferred, but the input device must be such that fast writing is possible. The ten keys in mobile phones in not fast enough, there must be a full set of alphabetic keys.

Again, faster access to the information is the main benefit of the mobile implementation of discussion groups and news services. If there is a need to get for example news services in real-time, broadcasting to a mobile device makes it possible.

5.2.5 Wireless E-commerce

There are several constraints of implementing wireless e-commerce in mobile world. Firstly, the transaction cannot require inputting too much data, the product in question must be identified with as simply as possible, for example with a serial number. Secondly, the description of the possible products must not require too much data or pictures. Because the handsets are so limited, it is not possible to show the ordered products with pictures and extensive descriptions. Thirdly, the security of the transferred data and money transactions must be guaranteed. Mobile media is considered to be more secure than physical networks, but the security at the end point must also be considered.

These challenges cause a situation, where the concept of wireless e-commerce sounds exciting and potential, but in every-day use the difficulty of using quickly becomes frustrating [7]. Therefore the example in Chapter 5.3 shows in practice a working model of the concept, but it must be kept in mind, that the concept works only, if the environment fills the strict constraints. The technology is still immature.

5.2.6 Service Management Functions

Service management was added to the list of possible services, because this and application area, where there already are working solutions. Even though this is not an application or a service by itself, it is an important part of all of them, and wireless media offers a way to implement it more cost-effectively and securely. One problem has always been the allocation and distribution of passwords in unsafe networks. Mobile network and transferring digital data through air is more secure and it offers a good way to carry out this task. Some other management functions like monitoring and user management could also be implemented with WAP devices.

5.2.7 New Mobile Services

New access method could also enable the implementation of totally new services. There are, for example, mobile phones that are equipped with Global Positioning System (GPS) and this technology combined with WAP protocol could offer a new set of services based on positioning. This kind of service could be for example an application that shows the nearest office in a certain area and the whereabouts of moving salesmen on the road and give information according to the location.

The integration of all messaging service into one device could also be possible with WAP-based devices. That is, email, fax, voicemail, calendar and telephony applications could all be used with the same handset. This kind of unified messaging would make the communication much more convenient and more efficient. However, the features of the handsets pose limitations to the applications of these kinds. For example, showing faxes with the limited display can cause problems. More applications ideas will probably come up as the penetration of end-user devices increases and the customers get more experiences of the technology.

5.2.8 Wireless Portal

All these previously mentioned services could be combined into a wireless portal, in the similar manner as in web-based extranets. The wireless portal would only be an extension to the company's business-to-business portal and it would contain the applications that are used in the company's extranets. That is, the idea is to offer a mobile access to the same portal, with the mobile world's restrictions. Chapter 5.5 illustrates the idea from the user's point of view.

5.3 SMS Substitutions

As the WAP handsets are not yet widely used in companies and it will take time for the new end-user devices to replace the old ones, the question of using existing technology, especially SMS, to create these services, has arisen. In a way, there is lock-in situation with SMS technology. The possible services that could be implemented with SMS are:

- Information delivery
- Service management

Because SMS has several technical limitations, the most difficult of these being the length of a SMS message, 160 characters, other services are out of question. Push and pull –type of information delivery is possible and some simple database query applications. However, in pull –type information service, it is required, that the user knows the 'key words' to activate the service and the number, where the message is sent. Push information can be easily delivered with SMS, and the data can be split to several SMS messages each 160 characters long. This kind of service is not very user friendly or simple enough that it would gain enough popularity.

SMS messages are already used in distributing the user ids and passwords for services. They offer a secure and easy media for carrying out the distribution (for example, www.messi.net is using this method). Some monitoring data could also be sent by SMS and service configuration could be carried out by simple SMS commands.

5.4 Example: Wireless Portal in Practice

This chapter illustrates the concept of wireless portal by showing end-user views to the service. The example views were created with Nokia WAP Toolkit and they only represent an example, no such service actually exists. The example is very simple just to get and idea what the current services are about and what the user interface looks like.

Before the end-user can connect to the extranet applications, the login procedure to the portal is carried out (Figure 11 a.). User id and the password to the portal are prompted. In an ideal case, the applications in the portal do not require a separate login, but the authentication is taken care of with a single-sign-on. After the user has given the user id and the password (Figure 11 b.), he/she can attempt the login to the portal. If the login is a success, the user is prompted to choose the service from the list of available applications (Figures 11 c.).

a. **b.** **c.**

Figure 11. Wireless Portal Example, part 1

In this case, the services are news service, some kind of database query service and a commerce application (Figure 12 a.). The user chooses the commerce. In this example, the commerce application is a very simple one: it finds products according to the serial number and sends them and the bill to a predefined address. No money transactions are made with the end-user device. In Figure 12 b. the user interface prompts for the serial number of the product to be ordered and in Figure 12 c. the user has given the number.

a. **b.** **c.**

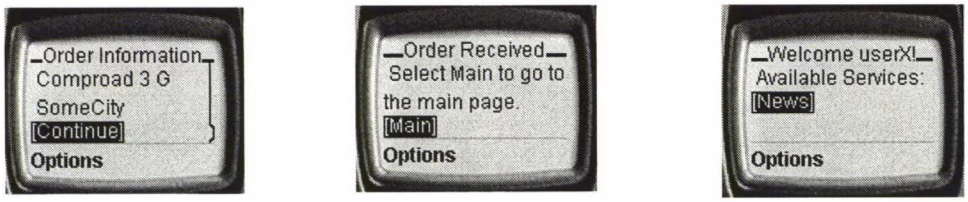
Figure 12. Wireless Portal Example, part 2

The application sends the number to the server and the product matching the number is fetched from the database. This is then sent back to the user (Figure 13 a.). The user checks that the product is the correct one and continues (Figure 13 b.). Subsequently, the ordering information of the user is shown (Figure 13 c).

a. **b.** **c.**

Figure 13. Wireless Portal Example, part 3

This information is also obtained from a database by using the user's id as a key. After the user has confirmed the order information (Figure 14 a.), the transaction takes place and the order is saved in the database and processed (Figure 14 b.). The user can then return to the portal main page and make another transaction or use the other services (Figure 14 c.).



a. **b.** **c.**

Figure 14. Wireless Portal Example, part 4

6 Technical Analysis

6.1 Wireless Extranet Infrastructure

This chapter briefly describes the integration of WAP technology to an existing implementation of extranet environment. There are several ways to carry out the task. This chapter includes only couple of possible solutions. The technology is not investigated in detail in this study, so the idea is presented only at a system level. The environment presented in Chapter 3.4 (Figure 7) is used as the basis for the wireless extranet infrastructure.

There are two ways to connect web services to a wireless network: a dedicated WAP gateway or a public WAP gateway. Public gateway means that there are several other companies using the same WAP gateway for their connections and the gateway server is hosted and operated by a third party, for example an operator. Another option, a dedicated gateway means that the gateway is used for only the company defined traffic and nothing else. The company or a third party can carry out the maintenance of the server. Basically, it is assumed here that the used gateways are dedicated, and the traffic from the gateway to the service needs not be encrypted. Companies providing classified information in their extranets should not trust a public gateway.

WAP applications can be transferred from ordinary web applications by HTML filter to WML or the applications may have the code in native WML. In the second case, no HTML filter is required. Converting large and (usually) non-standard HTML -pages to WML is in many cases impossible, or the result is unreadable. Therefore the case of HTML filter is left to less attention, as most applications will be implemented with native WML or XML. Thirdly, as it was stated earlier, WAP works on SMS as well as on GSM data bearer of current GSM technologies. Here it is assumed that the WAP clients are using GSM data as a bearer. The applications used in extranet require that much interactivity, data transfer and quality of service that using SMS would be too awkward and it could not meet the requirements.

WAP gateways can work as the filter, proxy, authentication server and/or as ordinary web server. WAP gateway also translates the WML into binary WML that can be sent to the mobile handset. In this sense, WAP gateway is quite an ambiguous concept and can perform several different tasks. These different tasks should be kept in mind when investigating the architecture examples.

One possible infrastructure for wireless extranet access is shown in Figure 15.

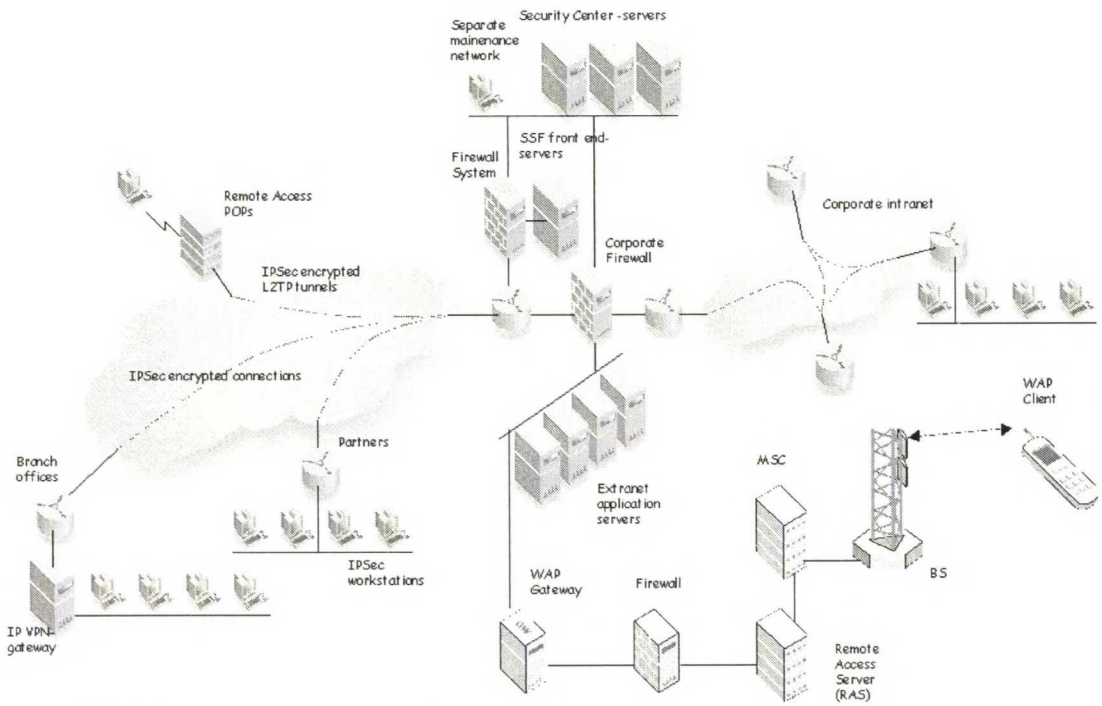


Figure 15. Wireless Extranet Architecture I

In this picture, a dedicated WAP gateway is directly connected to the extranet application server network. There is a firewall between the gateway and the remote access server. Firewall filters the unwanted connections from the network, because there is a direct TCP/IP connection from the gateway to the vulnerable trusted network. Authentication of the client can be done in several different entities (see Chapter 6.3.1).

The applications and the source code are on the application servers. WAP gateway converts the WML to binary format and sends the converted packets through the firewall. This conversion is carried out to reduce the traffic in the mobile network.

Because it is possible to send TCP/IP packets through the gateway, a firewall is needed between the Remote Access Server and the gateway. The GSM network is connected to RAS and the data call is established by using Point-to-Point Protocol (PPP).

Another similar infrastructure is presented in Figure 16. Here the WAP gateway is the only component that is directly connected to the same network as the application servers. If WAP client includes a certificate (or other authentication information, see Chapter 6.3.1), the authentication can carried out before the application servers and the gateway are accessed. This authentication information can be located in the Security Center –servers. The packets coming from and going to the mobile network go through the same firewall as the packets coming form and going to the Internet.

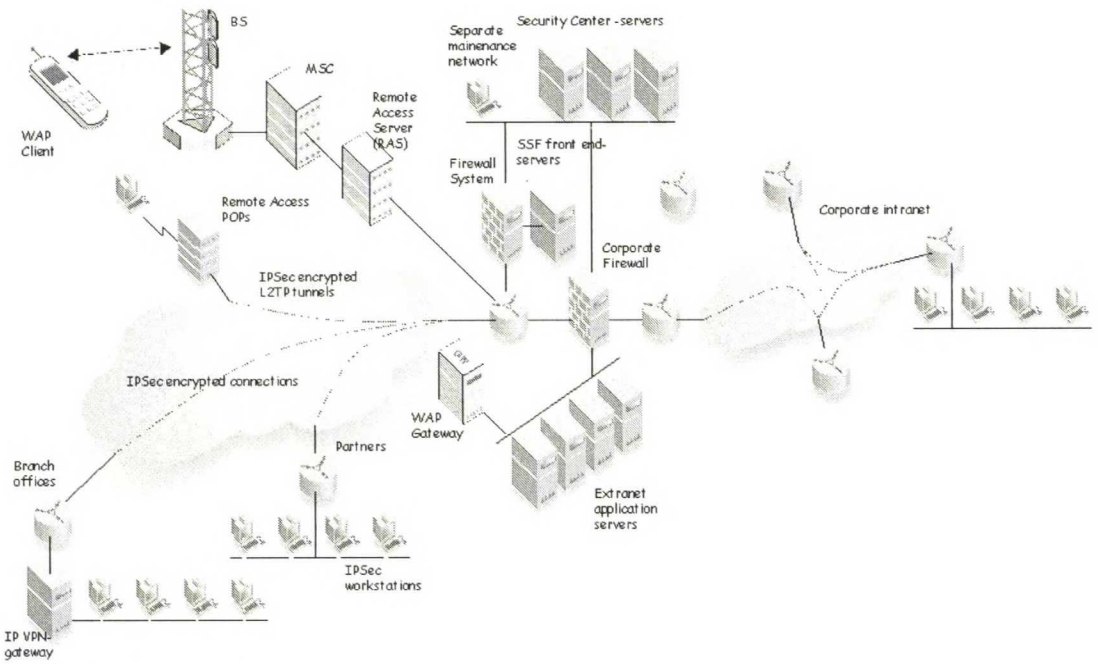


Figure 16. Wireless Extranet Architecture II

6.1.1 Role of Portal

Portal is the common access point for all the services. It should be transparent to the user and he/she should be able to access the same information and services, wherever he/she takes the connection from, be it the intranet, a branch office or mobile client. To

make this kind of service possible, the authorisation and the authentication of the user must be carried out dynamically, based on for example certificates.

Implementing the portal concept in the architecture requires additional software components in the front-end servers and extranet application servers. The user interface of the portal (web or mobile client) would be located in the front-end servers. The clients communicate with the LDAP servers that store all the user profiles and service information. The extranet application servers that store the actual used services would have to include special integration software that takes care of authorisation to the services and gathers logging information. No extra hardware components are required. The architecture becomes more complicated, if one-time passwords – for example SecurId – are used. Then an additional one-time password system server is needed.

6.2 *Interfaces*

From the previous chapter, the following essential interfaces can be recognised:

- Radio interface (between the client and BS)
- GSM interface (between MSC and RAS)
- Network interface (between RAS and WAP gateway)
- Server interface (between WAP gateway and the application server)

These are the most critical interfaces in the solution. Radio interface is the bottleneck, when considering the quality of service. It sets the most constraints to the data transfer, because the available bandwidth and network are limited. GSM interface is the boundary between the GSM network and the data network. Here the data is transferred from the GSM network subsystem to RAS that takes care of the access to the data networks. RAS manages and allocates the IP-addresses of the WAP clients. When a data call is established between the client and RAS a new IP –address is allocated by RAS to the WAP –client.

Network interface is critical, when considering the security of the system. Firewall should be set up on this boundary. When coming from the wireless networks, this is the

first TCP/IP-based network boundary and therefore vulnerable to attacks coming from the public TCP/IP network.

The interface between the application server and the WAP gateway should be considered as a 'safe' boundary. That is, the network is non-hostile. This interface is similar to the one between a WWW proxy and HTTP server.

6.2.1 Protocol Stacks

Figure 17 shows the protocol stack of the entities, where WAP protocols are needed. Other entities are not shown, because their functionality or protocols need not to be changed.

WAP client protocol stack is created during the call establishment. Point-to-point protocol is used to make a connection with the RAS and IP address is allocated for the client (PPP is under the IP –protocol, not shown in the picture). UDP is used as the datagram protocol on the top of the IP -protocol and WAP protocol stack comes on the top of that. Session protocol uses the 'browsing' mode. WAE user agent is the microbrowser in the phone.

WAP gateway may include the HTML filter and therefore it has two protocol stacks on top of the IP –protocols. However, it seems that the HTML filter option will not be widely used for the reasons explained earlier, and therefore it is marked with dashed lines.

Application server has also two protocol stacks, because it may have the applications in normal web format (HTML, Java, Perl) or in native WML and WMLScript formats. There may also some applications that take advantage of the WTA protocol, even though it is not mentioned in the protocol stack figure. For example, collecting billing information or call control applications might be services like this.

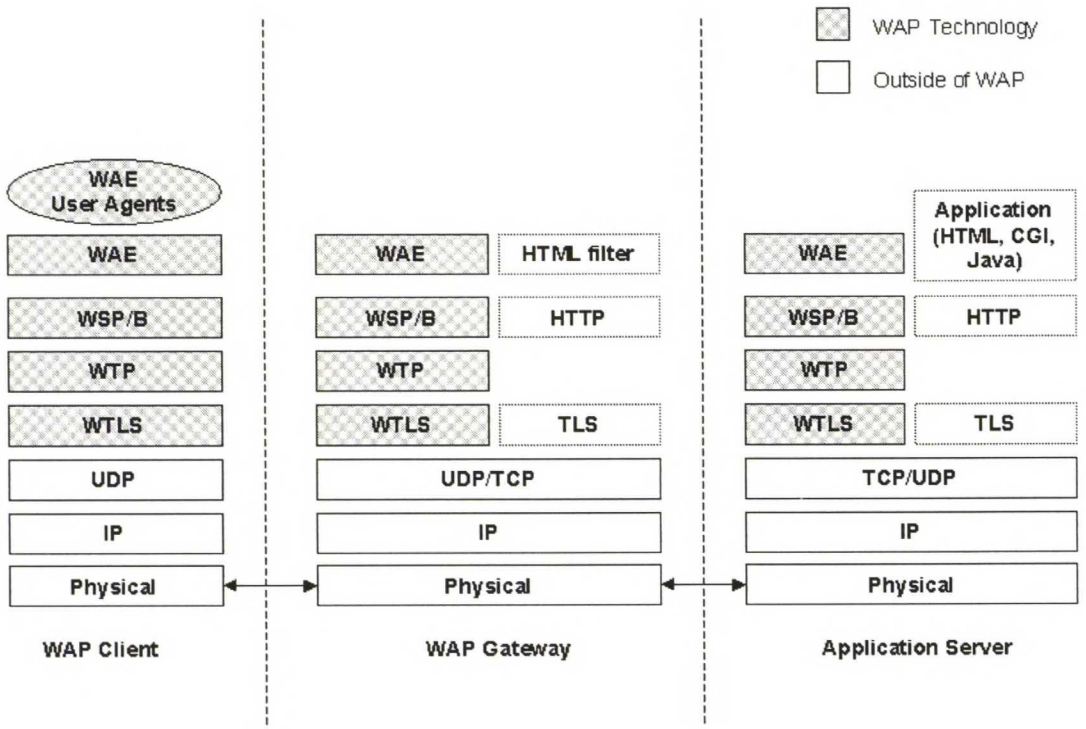


Figure 17. Example Protocol Stack

6.3 Security

The most important single service in extranet solutions is security. This chapter discusses the technical aspects of creating security in wireless extranet solutions. Authentication, authorisation and encryption are discussed separately. Confidentiality is important in all applications, but especially in services that might include money transactions or highly confidential documents, i.e. trade secrets. Strong authentication and encryption must then be enforced. Security issues are mainly approached from the corporate customer's point of view.

6.3.1 Authentication

Before authentication can be discussed, the concept of strong authentication must be defined. There are three ways to authenticate an entity, on the basis of following points [2]:

- something known: password, PIN, 'mother's maiden name'

- something possessed: physical key, magnetic card, token, smartcard
- something embodied: fingerprint, voice, retina, iris

Strong authentication is using more than one of these methods. In other words, it is not enough, that an entity is authenticated by using only password or smartcard, but they must be combined. Using both one-time passwords (generated for example by SecurId token) and regular passwords can be considered as strong authentication. In this case, SecurId token is 'something possessed'.

In the previously described infrastructure, there are several mechanisms to authenticate a client by not using strong authentication. These mechanisms have to be enforced in different entities in the network infrastructure. The possible mechanisms include the following:

- authentication by phone number (MSISDN) in RAS
- authentication by login and password
    - in WAP gateway
    - in the application server

The user can be authenticated in RAS, in the WAP gateway or in the application server itself. The authentication could be also done by using several of these methods, for example by phone number in RAS and by login and password in the application. This would still be a weak authentication mechanism, because it takes advantage of the same method: something known. If the password could be formed with SecurId token, it would be a strong authentication. The same thing applies, if SecurId token would be used in the WAP gateway authentication. Otherwise, all these methods are weak.

At the moment, it is not possible to use certificate-based authentication in WAP protocol. The proposed WAP version 1.2 includes mechanisms that enable strong authentication using a certificate stored in the SIM –card of the phone. [39]

6.3.2 Authorisation

The most convenient way for the user to be authorised for the wireless portal services would be single-sign-on. That is, the user gives the login information only once and after that the authorisation to all the correct services is done automatically. Technically this is now possible, if the authentication is done in the WAP gateway and the gateway server includes a possibility to rewrite the authentication mechanism.

After the user has been authenticated to the gateway, the login data can be passed to the application servers by adding the user's login-password combination to the end of POST field requested from the server. This way the user gets the access to all the applications he/she is allowed to access with the single login-password combination (provided that these applications are synchronised, i.e. use the same login information).

If the authentication is done in the application servers or in RAS, the user has to login to each service separately and he/she may have possibility to try to login to services that he/she is not allowed to. Or alternatively, he/she has an access to all possible services, which is not good security policy.

6.3.3 Encryption

The connection between the WAP client and the WAP gateway can be encrypted by using WTLS. Currently, WTLS does not offer strong encryption, even though it is possible to add new, more efficient algorithms to the protocol in the same way as in TLS. 3DES algorithm offers an adequate level of security, but is not as good as the most advanced encryption algorithms at the moment.

The connection between the extranet application server(s) and the gateway does not need to be encrypted. If there would be such need, the encryption could be carried out by using TLS, i.e. HTTPS –connection.

6.4 Service Categorisation

WAP 1.1 does not define any means to gather information about the features of the end-user device (the size of the display, memory, input device etc.) and therefore it is not possible to build services that would adapt according to the handsets capabilities. With current protocols, the services have to be built by the most constricted requirements.

WAP 1.2 will include features that allow the acquisition of the features of the handset to the server [23]. This will allow the categorisation of services and different 'versions' of applications to be created for different end-user devices. This feature will be very useful as the qualities of the end-user devices differ very much.

6.5 Alternative Technologies

At the moment, there is only one alternative technology that could hinder the development and the success of WAP technology. It is possible that there will be other alternative, competitive implementations of mobile Internet, but it is highly unlikely, because WAP has so wide support from different parties. Only the 'traditional' WWW model can threaten WAP at the moment. There are implementations, like Nokia Communicator 9110 that enable the use of World Wide Web directly with the mobile devices without any special extra protocol interfaces. However, these implementations are not very user-friendly or convenient, because most of the web pages and the wireless networks are not designed into such an environment. As the devices and the wireless networks (see Appendix I) develop, the need for the WAP technology could become obsolete, and the end users prefer the direct connection to WWW, even though it requires more power from the device and more bandwidth from the network. The users might choose laptops and mobile phones and a direct connection to the WWW instead of small mobile phone and a WAP-based technology.

The wireless network data speeds and the performance of small laptops are increasing rapidly. As the technology develops, it might outperform the need for a protocol stack

like WAP, because the customers are getting acquainted with the WWW model and do not want to take a new technology into use.

7 Business Analysis

7.1 Evolution of Wireless Extranet Services

The roll-out of WAP-based consumer services has already started and most of the key players in the business are developing their business-to-business applications as well. The penetration of end-user devices is still marginal and it will probably take at least a year before the provision of profitable WAP-based business-to-business services is possible. Therefore the wireless service portfolio should be built gradually, starting from the currently available technologies, especially SMS.

This chapter sketches the business development and roll-out of wireless services. Mostly the business aspects are investigated from the operators, namely Sonera's, point of view, but also the customer point of view is discussed. The recommended course of action would be to start offering the simple SMS-based services in to the existing extranet customers. After this these customers could be gradually introduced to new concepts and WAP services by using the marketing strategy discussed in Chapter 2, by first testing the concepts and developing the services in co-operation with the most innovative corporate customers.

7.1.1 SMS

The first services could be simple service management functions and information delivery applications offered as value-added features to the current services. For example, the e-commerce software could include weekly/daily service statistics (how many visitors, transactions, the peak values etc.) delivered by SMS to a pre-defined number. In addition, the delivery of user ids and passwords could be implemented with SMS. These services would not need to be separately billed, they would be offered in addition to the applications, as alternative solutions, to get the corporate customers acquainted with the mobile services and concepts.

7.1.2 Combined Services

The next step would be the introducing of WAP-based version of the SMS-based services. The information delivery services and the service management functions could be alternatively implemented with WAP handsets or GSM handsets without WAP cababilities. The WAP –version of the service could perhaps offer some more features, for example the passwords could be easily changed with a WAP application, when doing the same thing with SMS is not a very simple task.

Together with these first WAP functions, the first market and concept tests with only WAP services could be started. As the penetration of end-user devices grows, the pricing and billing strategies should be formed (see Chapter 7.3) and actual service applications could be set up.

7.1.3 Introducing New Mobile Services

There are several important points that should be considered related to the introduction of new WAP-based services. These include the following:

- Commercial risks in the new technology-based services
- Target customers
- Customer delivered value
- Pricing and billing

The next chapters will discuss these problems on the base of the theory introduced in Chapter 2. The purpose is to find some initial solutions and answers to the questions involved. Hopefully some possible recommendations on how to proceed with the development and business strategy can be also presented.

7.2 Risks

The economic risks in the product development and commercialisation, and the probability for success can be calculated by using the tools presented in Chapter 2. The basis for the discussion is Sonera's current situation and the wireless portal concept.

These different results give some guidelines on how the future looks like and they mainly present the authors opinions on the subject.

The probability for overall success for wireless portal developed and commercialised by Sonera and based on WAP can be estimated by using the formula presented in Chapter 2.2.1. The three partial probabilities must first be estimated. At the moment, the technological risks in developing WAP-based services are low. Even though the standard is still developing, it is supported by all the parties in the business and it is in everybody's interest that the technological completion of the services is possible. Secondly, technologically very similar consumer services already exist, even though they have technically fewer requirements than in business-to-business environment. Therefore, the estimated probability for technical completion for wireless extranet portal is 0.95. The deviation for this probability is not very high, because it is supported by clear facts.

The probability for commercialisation given technical completion can be also set high. This can be justified with the following reasons:

1. Several companies have announced that they will commercialise WAP-based business-to-business services
2. Sonera has the necessary infrastructure and ready WAP platform to commercialise the products
3. The markets are expecting commercialisation from Sonera, because of its reputation and strategy

Based on these reasons, the second probability is estimated as 0.85. The deviation for this number is higher, because of the uncertainty of the business and the success of the WAP services in the consumer markets. The commercialisation will depend to some extend on the success of the consumer services, because they were introduced first.

The third probability is hardest to estimate. Given commercialisation, the probability for economic success has several uncertainty factors. Firstly, the technology must be able to meet the requirements of the business-to-business environment. There are currently no facts supporting that it will. Secondly, the pricing and billing must be such

that the need meets the demand. This point is discussed in the following chapters. The third factor affecting on this probability is competition, which most probably will be hard in the business. Wireless e-commerce and services will be offered by several global as well as local companies and the success will highly depend on how competitive Sonera's services will be. However, the forecasts for the markets and also for Sonera's future success are estimated high (stock market expectations, international publicity). To conclude, the probability for economic success is set to 0.7, which, however, has a high error deviation, because of the previously mentioned uncertainty factors.

These three probabilities give us the overall probability for success:

$$\textit{Overall Probability For Success} = 0.95 \times 0.85 \times 0.7 = 0.56525 \qquad (7.1)$$

Thus the overall probability for success of WAP-based service, especially wireless portal concept, is estimated at 57%. This figure should be re-calculated, as the market situation and the technologies develop, but at this point it offers a fairly good estimation. It is only a guideline, a rough estimate that can be used, when deciding if these services should be developed.

Second point of view on the risks of WAP service development is the seven key assets listed by Shapiro and discussed in Chapter 2. These points can be considered one by one by comparing them with Sonera Solutions' current situation, and what risks they might cause:

1. Control over an installed base of customers. Sonera has an installed base of customers and fairly high level of dedication from these customers, because they are depending on Sonera usually on several solutions. Many of them are leading companies in the industry.
2. Intellectual property rights. Sonera has no rights or patents related specifically to WAP technology.

3. Ability to innovate. At the moment Sonera is considered as an innovative forerunner on telecommunications and technology.
4. First-mover advantages. Sonera was the first one to introduce WAP-based consumer services in Finland and among the first ones in the world. During the last years, Sonera has pushed first-mover strategy on several services and technologies.
5. Manufacturing abilities. Sonera has an ability to produce both data services as well as mobile services. It operates and has a market leader position in a country where both Internet and mobile product penetration is high and companies are ready to try with new, innovative products.
6. Strength in complements. At the moment there are no actual complements in wireless e-commerce. However, Sonera has developed other mobile services as well as e-commerce services and data services, so this point can be considered as it strength.
7. Reputation and brand name. Currently Sonera does not have a global brand, even though its reputation is innovative and reliable on producing new services. Sonera his highly appreciated for example in NASDAQ stock exchange.

If these seven key assets are considered, Sonera has fairy good chances for success in developing business-to-business WAP services. Sonera has no patents or copyright related specifically to WAP technology and no global brand or reputation, but otherwise it has several strengths that support the success of the development. However, as it was stated in Chapter 3.5, brand is perhaps the most important asset of these all and this is what Sonera is lacking at the moment. Therefore partnerships and joint ventures should be utilised as much as possible.

The weighted index method can also be used to evaluate the usefulness of wireless portal concept. The ratings given in the Table 3 are author's estimates. At this point there are no facts available that would justify or support the figures. The product score for high performance-to-cost ratio is based on the calculations made in Chapter 7.6. Other scores are pure estimates based on several assumptions and current market situation. Total rating 0.74 is clearly above the minimum acceptance rate.

Table 3. Evaluation of Wireless Portal using Weighted Index Method

	Relative Weight	Concept Score	Concept Rating
Product Success Requirements	**(A)**	**(B)**	**C=A x B**
Unique or superior product	.40	.85	.34
High performance-to-cost ratio	.30	.7	.21
High marketing dollar support	.20	.7	.14
Lack of strong competition	.10	.5	.05
Total	1.00		.74

Rating scale: .00-.30 poor; .31-.60 fair; .61-.80 good. Minimum acceptance rate: .61

7.3 Marketing

A marketing approach is taken in this chapter. The most essential concepts, like target customer selection, ROI and commercialisation are investigated. The technical implementation of the services will most probably not be the problem, but the marketing and finding the right lead customers for the services. As the convergence of mobile and data networks is unfamiliar in most of the companies, the right marketing approach is crucial.

7.3.1 Target Customers

Determining the customer groups, the applications, and the ones that are interested in using the new technology starts the selection of target customers. Among these companies, the most innovative are picked as the lead customers, the 'test markets'. When considering the WAP-based extranet services, the potential customer company must fill at least the following criteria:

1. Need for mobile services. The target customer must have a lot of mobile users, travellers. It may have several locations and moving employees that need access to the applications from the road. The operation of the customer might be so time-critical that an access to the essential services is needed all the time.

2. Networked company. Partnerships, subsidiaries and other company networks are required. There might be some type of extranet already in use.
3. Innovative company. The company must be ready to experiment with new technologies and services. They must be interested in investing on services that have no history and proven customer base installed.

In the market applications matrix (Figure 2) the market entry point of wireless WAP-based portal mainly lies in the expansion quadrant. The customers are the same existing companies that are developing extranets at the moment, but the services are new, i.e. there can be totally new applications or the old applications are used with a totally new access method and end-user device. The new technology requires some considerable changes in the end-user behaviour, and using IP applications with a mobile phone is not achievable with the established technology to the extend that users would prefer it (Nokia Communicator can be considered as an exception, most of the IP servicesdo not work with it).

To be more concrete, the possible target customer markets can be illustrated with a some practical examples. A good example for the need for mobility in a networked environment is the public sector. The network of public services, like health care, police and the registry office would greatly benefit, if they had a common access point and mobile access to their databases. The mobile police could get the access to the registry database with their mobile phones, the same goes with emergency personnel. It is also required that only the authorised personnel can get the access to the personal data, like criminal records. The platform could also offer the possibility for ordinary citizens to check their own personal data. The authentication could be based on for example the certificates stored on the personal identification smartcards. The public sector network would offer an ideal environment for implementing a mobile extranet solution. The only requirement is that the information systems are modern enough that it is possible to build such a service network.

Another simple example of a networked industry and the need for mobility is logistics business. Large national or multinational logistics companies or company networks (for example Kaukokiito in Finland) need a solution where their information systems could

have a mobile and secure access. For example, the truck drivers on the road could check the location of the nearest loading place or check the situation of a certain depot with the mobile client. The moving workers could get different types of broadcasted information (weather conditions, road information, sleeping places etc.) to the road and the databases and confidential information services (warehouse statistics, spare part prices etc.) would be accessible to only authorised users. At the moment, the communication is carried out with mobile voice (usually NMT-based) and some very simple applications and requires additional personnel and many levels between the end user and the information system. The direct interfacing with the database systems or receiving real-time information on the road is not possible with current solutions.

7.3.2 Commercialisation

The strategy to pursue with WAP-based service commercialisation should be first entry. This is because of the Sonera's reputation and the possible to gain large market shares by being the forerunner. In addition, the companies in Finland offer an excellent test market to launch innovative services.

These services are easily ported to other countries, where GSM is available. The introductory market strategy and the geographical positioning should be developed according to the operator's overall strategy for extranet services.

7.4 Market forecasts

[7] states several strategic planning assumptions about the markets. According to the note, by 2005 the leading global e-business companies will generate up to 20 percent of their business through the mobile phone (and other wireless devices) as their most qualified retail outlets (0.6 probability). It is expected that market development for e-commerce will accelerate first in Europe, since it has a single digital wireless standard and mobile users already outnumber Internet users by three to one [7].

[28] estimates that the number of WAP subscribers in 2003 is about 30 million and the number of SMS subscribers in the same year is 82 million. The study implies that WAP

services will see steady growth although the higher penetration of SMS services will inhibit the growth of WAP, since users are already receiving much of the information they require. It must be noted that this study concerns both business-to-consumer and business-to-business users. In author's opinion, SMS will not be a suitable platform for business-to-business services and therefore it is unlikely that WAP and SMS will compete of the business customers.

7.5 Pricing and Billing

Pricing and billing are difficult subjects. There are several alternatives for pricing the value-added wireless services. Currently, the business-to-consumer WAP services (on GSM data) have double-barrelled pricing. Firstly, the data call is charged on time-based charge per minute. Secondly, the transaction service itself has a separate fixed charge in the similar manner as in SMS services.

The objective of pricing the WAP services should be maximum market share, because getting the customer probably means a long-time customer relationship. This is usually the case with normal corporate data services. However, the pricing scheme should also meet the profitability requirements of the service provider.

The problem with business-to-business services is that they are not offered as separate services, but as value-added parts of larger customer solutions. Therefore the pricing logic will be different from the consumer services. Volume-based billing is possible, but it does not necessarily offer the best possible advantage over competitors and cost-effectiveness for the customers. Some possible pricing schemes are:

1. Fixed pricing. One fixed fee for the total service, based either on the amount of users or the amount of services etc.
2. Double-barrelled fixed pricing. Fixed fee for the service usage and a time-based charging for the data calls.
3. Double-barrelled volume-based pricing. Both the services and the calls have volume-based billing.

4. Combined pricing. The pricing of the wireless services is somehow linked to the pricing of the services in the physical network. For example, one user has a fixed monthly fee and it does not matter, if he/she uses the mobile or the physical access to the service.

The actual problem with the fixed and double-barrelled pricing schemes is that the pricing (and billing) of these two different components is carried out by the different organisational units that do not most probably have any co-operation with each other. It will require some organisational changes from the operator in order to be able to have reasonable and common pricing schemes.

The author's opinion is that the best option at the moment would be a fixed service fee based on the number of mobile users and the data calls would be priced separately according to the normal call fees. In addition, there would be an initial fee for the establishment of the service. This kind of system would not be a radical change to the current mobile and Internet application pricing and therefore would not require a change in the way the customers see the costs of these services.

A simplified example of the pricing scheme can be presented. The current pricing of consumer WAP data calls is 0.99 FIM/min + outgoing data call fee 0.68 FIM/call. It can be assumed that the prices for corporate customers are about the same.

The monthly and establishment fees in the suggested pricing scheme for an organisation with n users could be calculated with the following formula (t is the time in minutes of the approximate length of one call, C is the approximate number of calls made by one user in one month, the tariffs are 0.99 FIM/min + 0.68 FIM/call, M is the fixed monthly fee per user and E is the fixed establishment fee per user):

$$\textit{Monthly Fee} = N \times (C \times (0.99\,t + 0.68) + M) \qquad (7.2)$$

The establishment fee is simply

$$\textit{Establishment Fee} = M \times N \qquad (7.3)$$

The establishment of the service could be for example 300 FIM/user and the fixed monthly fee 100 FIM/user (see also Chapter 7.6.2 for evaluating the costs of the service provider). In consumer services there is no fixed monthly fee, but each WAP transaction is charged separately in the similar manner as in SMS services. The fee for single transaction is 1.89-3.50 FIM. In corporate environment, it is more convenient and in most cases also cost effective for the customer to have a fixed fee for the use of the services, because predicting costs is easier.

If there are 300 mobile users in an organisation, the revenues for the service provider with different call volumes are shown in Table 4. All the numbers are in FIMs. The different approximate durations of one data call (from 1 min to 10 min) and the approximate number of calls per user are presented (from 15 to 50). The table shows that if the approximate duration of one call is 3 min and one user makes 30 calls in a month, the costs of the service for 300 users would be 90000 FIM for the establishment and 62850 FIM for fixed monthly fee. Chapter 7.6 discusses the benefits and costs further and uses this example as a framework.

Table 4. Service Provider Revenues (in FIMs)

Establishment Fee				90000
Monthly Fixed Fee				30000
	1 min / call	**3 min / call**	**5 min / call**	**10 min / call**
15 calls / user	7515	16425	25335	47610
30 calls / user	15030	32850	50670	95220
50 calls / user	25050	54750	84450	158700
Total establishment fee				**90000 FIM**
Total monthly fee (30 calls and 3 min/call)				**62850 FIM**

7.6 *Evaluating Costs and Profits*

7.6.1 Calculating the ROI for Wireless Portal

The example costs for the customer in buying a WAP solution from a service provider were shown in the previous chapter. ROI framework offers and excellent guideline for estimating the relation of costs and profits to the customer. Table 4 offers a synopsis of possible ROI components, which apply to the extranet strategies that will be most prevalent over the next 18 to 36 months. The table is based on [32] with additions by the author. Added mobile access components are represented with italic letters. Benefits and risks are divided into two categories, tangible and intangible. This kind of ROI framework is a good strategy planning tool for customer companies and a marketing tool for the operator.

As it can be seen, the wireless access does not bring many new components to the framework. However, the new value-added services will have an impact on the existing components. New mobile technology factor must be taken into consideration, when evaluating the values for the components.

Table 5. Wireless Portal Case ROI Components

Tangible Benefits	Increased sales	Increased number of customers	Gain exposure in new markets	Decreased cost of sales	Focused sales efforts on new market segments	Decreased cost of publishing product information	Business process operational improvement
	Decreased number of suppliers	Decreased time to process and fill orders	Decreased cost of supplies	Faster time to market	Focused diversificatio n of product offerings	Increased customer calls per rep	*Faster time to access the product information*
	Increased number of suppliers						
Intangible Benefits	Expanded brand awareness	Better customer/ supplier satisfaction	Knowledge of Internet-based technologies	Increased internal IT skills	Quick response to customer preference	Faster adoption of improved or new technologies	Rapidity of marketing message delivery
	Increased ability to support competitive BPR initiatives	Support of business goals	*Knowledge of new mobile technologies*				
	Improved distribution channel satisfaction						
Tangible Cost/Risk	Increased cost of marketing the new channel	Cost of increased transactions	Risen franchise-ment of external sales channels	Increased IT costs	Internal training costs	Customer training and support	Business process re-engineering
	Assessment of supplier readiness	Assessment of customer readiness	Predictable cost of handling increased transactions	Outsourcing	Analysis of data-level security needs	Cost of security measures	Increased supplier and business partner training and support
Intangible Cost/Risk	Competitive encroachment	Decreased customer loyalty	"One-upmanship" of Web features and sites	Increased customer expectations	Pointers to competitors	Inconsistent effect on sales channels	Employee resistance to change
	Supplier/ partner resistance to change	Commodi-tisation of products	*Failure of the new technology*	Customer resistance to change			

There are several techniques for calculating the return on investment. Among them are the Payback Period, Net Present Value (NPV), and Internal Rate of Return (IRR). For the purposes of this study, the simplest Net Present Value is recommended. The Net Present Value method is similar to calculating and income statement – all costs and benefits are first discounted to the time of the investment and the total costs are subtracted from total revenues to return a profit number. [3] The formula for Payback Period is

$$Payback\ Period = \frac{Acquisition\ Price}{Annual\ Income} \quad (7.4)$$

The basic formula for ROI is

$$ROI = \frac{Profit}{Investment} \times 100\ \% \quad (7.5)$$

For example, if the total tangible savings for the company in the example in Chapter 7.5 would be 1 000 000 FIM per year and the total costs being 90 000 FIM + 12 * 62850 FIM, the ROI for the mobile service investments would be

$$\frac{1\ 000\ 000}{90\ 000 + 12 \times 62850} \times 100\ \% = 118\ \% \quad (7.6)$$

In other words, the net present value of the investment is

$$1\ 000\ 000 - (\ 90\ 000 + 12 \times 62\ 850\ ) = 155\ 800\ FIM \quad (7.7)$$

if no interests are taken into account.

This traditional ROI method is meant to be used with tangible quantities, and therein lies one of the many barriers to determining ROI. However, the exercise of measuring ROI can become a tool for discussing the cause-and-effect relationship between mobile extranet and the achievement of strategic business goals – and a good way to build business buy-in. [3] ROI figures can also work as a marketing tool for the service provider.

7.6.2 Comparing Customer Costs

A comparison of the costs to the customer between the cases of service provider WAP solution and the solution developed in-house can be made. The main costs for buying the service from an operator were presented in Chapter 7.5. In addition to the direct costs, the costs of training the personnel to use the new services can be counted. These

costs are estimated to 5000 FIM /user, in other words the total costs for the first year of deployment in an organisation of 300 users are 2 254 200 FIM. These are the costs of service provider solution.

If the company decides to develop and implement the WAP solution in-house, the development costs are as follows. The costs consist of the following components:

- Hardware costs
- Software development costs
- Personnel costs
- Data call costs
- Maintenance costs

The hardware acquisition and software development costs will at minimum be 3 million FIM (see the next chapter). Data call costs will remain the same as with service provider solution, because this service must in any case be bought from a telecom operator.

It is reasonable to claim that the total costs for developing a dedicated WAP-based solution in-house will cost at minimum 5 to 10 million FIM. One must also consider that the wireless environment is only a part of the larger communication system that includes also the fixed network components. Even though all the presented figures are just rough estimates, buying the services from service providers will be much more cost-effective, especially if the provision can be concentrated on one or two companies.

7.6.3 Operator

The basic costs of service provider are summarised in Table 5. The table offers only a simplified list of the possible cost components related to the development, commercialisation and production of the service. No intangible costs or risks were taken into account.

Table 6. Operator Cost Components

Development Costs	Hardware and physical data line costs	Software costs	Software development costs	Personnel costs
Commercialisation Costs	Marketing costs	Personnel costs		
Production Costs	Maintenance costs	Data traffic costs	Personnel costs	

It is essential to understand in the estimation of the service provider costs that the profitability depends mainly on the development costs. That is, the development costs – and especially internal development costs – are the most sensitive cost component in the process. This is because the infrastructure, platform, marketing and billing systems etc. already exist and no large investments are required on them. This is the case especially, if the new mobile services are offered to the existing customers.

Some estimates on the tangible development costs can be given. The prices of WAP gateway have been estimated by [23] to minimum half a million dollars. However, the implementation of the gateway with software is not very complex and because of competition (small Finnish company called WapIT Ltd is developing an open source version of the gateway [23]), the prices will not be that high. An estimate of 2 million FIM is given to the gateway software. There is no information available, if this software can be used for implementing several customer solutions, or just one. It is reasonable to expect that it can be used for several implementations.

The new hardware investments to the infrastructure can be identified from the example in Chapter 6. The WAP gateway hardware and RAS are totally new components. MSC, other mobile network components and firewall can be implemented with the existing operator components. If they would be taken into account, the costs would rise considerably. In this example they are neglected. WAP –gateway software runs on normal platform (Sun, UNIX, Windows NT etc. depending on the vendor) and the hardware costs for it are marginal (< 100 000 FIM). RAS hardware with necessary software are estimated to cause costs of 100 000 FIM to 300 000 FIM per customer. These costs depend highly on the complexity of the solution, i.e. how many offices are

included, what geographical areas are the end-users on (national, international), what kinds of applications are used (i.e. how much bandwidth is required etc.).

The development of the necessary software for implementing the wireless portal is the most difficult one to estimate. It is here assumed that the development costs are around 2 million FIM, which is an approximate cost for a fairly large software development cost. The estimation is based on author's experience.

A simple Payback Period calculation can be performed with these figures. If it is assumed that the WAP gateway software can be used for 4 customers, the cost for one customer would be 500 000 FIM. The total fixed development costs would then be

WAP gateway + *Hardware* + *Software development* =

2 000 000 + *500 000* + *2 000 000* = *4 500 000 FIM* *(7.8)*

If there are four customers according to the service provider revenues in the example, the payback period for the operator would be

$$\frac{\textit{Development costs}}{\textit{Annual income}} = \frac{4\,500\,000}{4 \times 844\,200} = 1.3 \text{ years} \qquad (7.9)$$

So, the payback period for the fixed development costs with four customers and with the given pricing would be 1.3 years. This example gives a simplified picture how the service provider's costs can be estimated with fairly simple tools. The reality is more complex and evaluating the true values of different components is a complex and difficult task.

8 Conclusions

This study gave an overall picture of how the new WAP technology could be utilised in business-to-business environment, especially in extranet services. The point of view was mainly the service provider's, but some corporate customer aspects were also considered. Thus the research problem was stated as: how could the WAP technology be utilised in the extranet service provision business to increase sales and obtain new customers?

To answer the research question, the theory of developing new services using new technologies was first discussed. The main emphasis was on how to identify the risks and costs and how to spot the target customer for the new services. Commercialisation of the products was also discussed. There are several analysis tools available for conducting research in these subjects.

The extranet business environment was presented and the typical customer problems were examined. The corporate customers' problems can be divided into two main areas: communication and security. The different applications used in extranets must contribute to improving communication and they must be offered with enforced security. The concept of business-to-business portal was presented as one solution to these problems. Portal is a common access point to all offered services in company's extranet. It utilises unified security policy and demilitarised zone for carrying out the operational tasks.

Subsequently, the WAP technology was analysed. Current version of the standard is 1.2. The protocol stack allows the direct interfacing between a TCP/IP medium and a mobile station medium and that it specifies an application environment including a microbrowser, scripting, telephony value-added services and content formats. WAP offers an excellent platform to offer mobile text services that do not require high level of interaction or large amount of data transfer. There are only a couple of handsets that support WAP on the market at the moment, but several operators are already providing consumer services.

The possible applications of WAP technology in a company's extranet include information delivery services, database query services, customer services, discussion groups and news services, wireless e-commerce and service management functions. The new protocol can also enable new kinds of services, for example based on GPS. Integration of old applications into a new one with unified messaging can also be possible. The environment and end-user devices create a new kind of access method to the old services. The wireless business-to-business portal concept was introduced to correspond to the web-based portal. This portal would have the same function as in data networks and the same kinds of applications, but accommodated to the wireless environment.

In the technical part of the study, the possibilities to integrate the new technology to an existing operator platform were analysed. There are several different ways to connect the wireless devices to the company's extranet, but offering high level of security causes most problems. Because the currently supported WAP standard (1.1) does not support certificates, implementing strong authentication is complex and there are no user-friendly solutions. An adequate level of encryption can be offered with current technology. The portal in the architecture is created with integration software in the application servers and it does not require any additional hardware investments, because all the required components already exist in the current operator platform. Building the wireless solution from scratch would require massive investments and development costs.

It must also be noted that the penetration of end-user devices is still marginal, and it will take time until the mobile phones that support WAP are common enough and the services are attractive and profitable. Replacing the old phones with WAP-enabled devices will cause switching costs and will only happen during a fairly long time period. The length of this period is highly dependable on the handset vendors and the introduction of new models.

As the technology is still immature and the penetration of handsets is marginal, there has been discussion about offering wireless services with SMS. In a way it can be said that there is a lock-in with SMS, because all the current handsets support it, but not

WAP. However, SMS protocol is so limited that only very simple tasks can be carried out with it. These tasks are simple information services and management functions.

The business analysis part of the study concentrated on the problems in developing and commercialising WAP-based business-to-business services. When considering Sonera's situation, the company has several key assets that enable success when introducing new innovative services. A global brand is the only truly important asset that Sonera is lacking. Therefore partnerships and joint ventures are recommended for getting into the international markets. Creating credible security solutions also requires partnering with a security solution provider, because Sonera does not have the necessary resources.

The possible target customers for the new services would be innovative, technology-oriented and networked companies that have a need for mobile services in their operations. For example, they have a lot of mobile workers and the need to access the information systems from the road and from places where connecting to a fixed network is impossible. As examples of these kinds of environments, the public sector and logistics businesses were given. These companies lie mainly in the expansion quadrant of the market applications matrix, because the wireless services are only an alternative access method to the old services and the target markets are the existing customers.

Pricing and billing with WAP-based services is difficult, because they require new logic and possible organisational changes. The most preferable pricing method would be a common fixed price for the services and/or volume-based pricing according to the number of users. Currently, the data calls and application transactions must be billed separately. The transaction services should not be priced volume-based, because this kind of pricing scheme would not be cost-effective to the customer.

Estimating costs and profits includes two different points of view: the service provider's and corporate customer's. The customer's costs and profits can be divided into two groups: tangible and intangible, and the components for calculating the ROI can be formed from these costs and benefits. The wireless environment does not bring

many new components to the framework of calculating the ROI for extranet, but it has an effect on the existing components. An example ROI was calculated with a simplified example of tangible costs and savings. In the example, the return on investments for the customer was 118 %. If the costs of building the wireless solution in-house and buying the solution from a service provider are compared, it can be concluded that it is more cost-effective to buy the services.

In estimating the service provider's costs and profits, simple break-even analysis is preferable, because the process still contains so many uncertainty factors. The internal development costs are the most sensitive component in the cost framework, because they require the largest investments and contain the most uncertainty factors, other components are mostly fixed. A simplified example of the payback period was presented as a framework for discussion. In the example, the payback period of the tangible development costs was 1.3 years.

As a final conclusion, WAP technology has still a long road ahead. All the current forecasts predict success for the mobile data services, but the true success stories will be reality only after several years. The convergence of the mobile world and Internet has just started. Originally the WAP standard was developed for business-to-consumer services, but with the additions in version 1.2 of the protocol stack, it will also be suitable for the business-to-business environment. Finding the target customers and making the right decisions in development and commercialisation are essential for grasping the business opportunity.

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APPENDIX I: GSM Technology Development

Introduction

This chapter takes a quick look on the current situation of GSM system and its future development steps toward the mobile network of third generation. The subject is important from the point of view of this thesis, because these development steps have also an effect on the services that can be offered on the top of them. While current GSM offers only circuit-switched, low-bandwidth services, the enhancements in the system will develop the services to a much higher level. It is important to understand the features of these services, if one wants to evaluate the added value of the actual applications that can be produced using these bearers.

The GSM cellular market is the single largest technology installed world-wide, with some 135.2 million subscribers (45% of the total) in 129 countries world-wide at end-1998. Thus, it is to be expected that many of the advanced developments in wireless services arise from vendors and operators investing in new services and applications for GSM technology [26].

The evolution of GSM is currently in phase 2+. Figure 4 shows the release timetable for data features specified in ETSI. The first HSCSD services have been introduced by Sonera in Finland [Kummumäki]. GPRS is still to come, it requires some significant investments in the infrastructure of the GSM network.

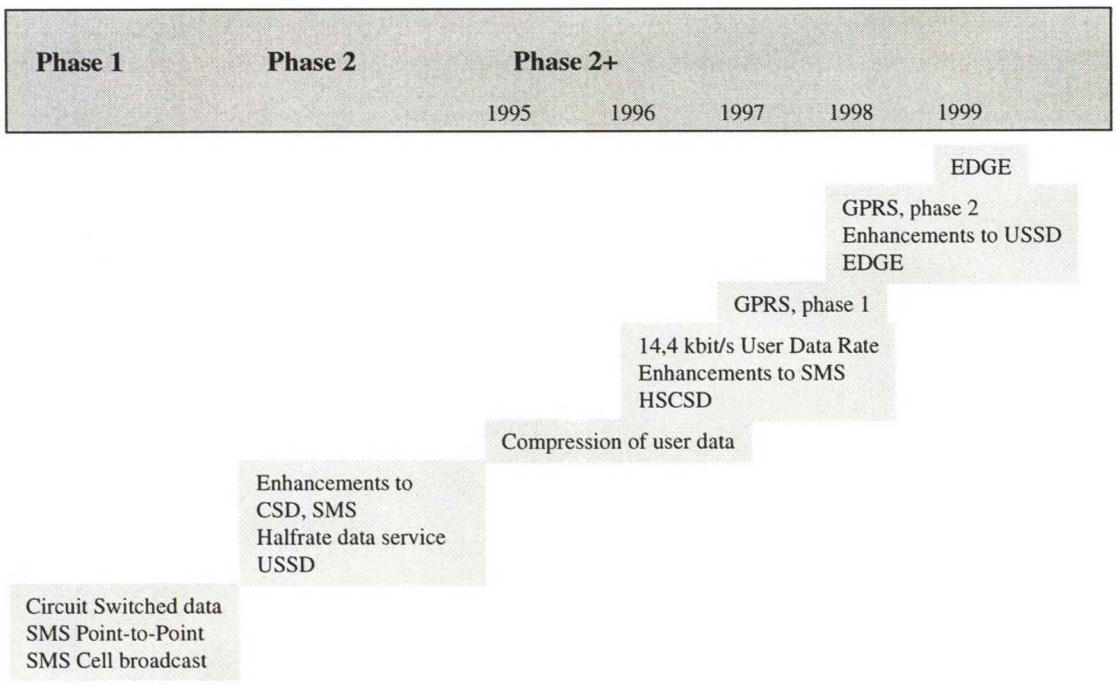

Figure 18. Release timetable of data features in ETSI GSM specification [29]

GSM

The original Phase 1 GSM system offered basic data services. Most services, which are provided to fixed telephony users and to Integrated Services Digital Network (ISDN) users have been included, as far as limitations to radio transfer allow [29]. These services include SMS point-to-point, cell broadcast and circuit switched data with the speed of 9.6 kbit/s. Recently, the circuit switched speed has been upgraded to 14.4 kbit/s using Enhanced Full Rate (EFR) technology [26]. The problem is that such data speeds are acceptable for simple e-mail services but not for multimedia such as Internet browsing.

Short Message Service

SMS point-to-point and SMS cell-broadcast allow for carrying messages, of limited length (160 characters), using the signalling channel. SMS is a store and forward

service: the message is stored in a SMS service center until the message can be delivered to the mobile phone. [5]

Over the past two years, the growth of SMS traffic in Europe has been tremendous, which illustrates the potential that non-voice services can have for the operator community. Growth has primarily been driven by text-based person-to-person messaging, but increasingly by notification services (apart from voice-mail notification, e-mail notification is emerging rapidly) and text-based information services. Apart from delivering text-based information directly to the end-user, SMS has also become an important enabler for the introduction of new services. [5]

GSM High Speed Circuit Switched Data (HSCSD)

HSCSD provides a single user with not one time slot, as in the standard circuit switched option, but several. It provides 9.6 kbit/s per time slot and by using up to eight time slots, would provide a transmission rate of 76.8 kbit/s, theoretically. The new service requires minimal changes to specifications; mostly software changes to existing GSM infrastructure. Existing cellular phones and data cards can not utilise the new service and therefore there is a need for subscribers to purchase new handsets. [26]

Sonera has already launched its HSCSD service, the maximum data rate offered is 38.4 kbit/s. The maximum rate is limited, because the available bandwidth would run out fast with current infrastructure [19]. However, there are no handsets on the markets that would utilize HSCSD at the moment. These phones should be introduced during this year.

GSM General Packet Radio Services (GPRS)

GPRS provides an end-user with a packet connection over the GSM network. It will interwork with the circuit switched services and provide 14.4 kbit/s over a single time slot and 115 kbit/s over eight time slots. The service can be introduced over the existing installed infrastructure, with network resources allocated dynamically between circuit and packet switched (both connectionless and connection orientated X.25). GPRS is

optimised for 'bursty' data communications services such as Internet access and access to corporate Intranets, like the fixed packet networks. Users are permanently connected but only pay for the volume of data that is transported. GPRS also facilitates implementation of voice services over the Internet Protocol (IP). [26]

Important aspects of the GPRS include the following [5]:

- Packet access in the radio interface; share access of radio channels
- Packet-switched network infrastructure; IP-based using TCP and User Datagram Protocol
- Possibility for volume-based charging
- Peak data rates of up to 149.8 kbit/s
- Ability to migrate towards UMTS
- V.42bis compression

Many operators around the world have contracted to implement such services, but they probably will not be operational prior to 2000. This includes T-Mobil in Germany, Sonera in Finland, BT Cellnet, One2One and Vodafone in the UK and Omnipoint in the USA. [26]

Enhanced Data Rate for GSM Evolution (EDGE)

EDGE is the peak of GSM data evolution. It's a high-speed mobile standard, which offers effectively enhanced channel coding for GPRS in order to achieve data transmission speeds of 386 kbit/s.

EDGE requires higher radio signal quality than that found in an average GSM network before higher data throughput speeds can be reached. This means more BTSs and infrastructure buildout for established GSM operators that wish to migrate to EDGE. The compatibility with GSM allows EDGE to be rolled out gradually, users stepping down to GPRS speeds in areas where EDGE signal strength is insufficient. [5].