LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
Department of Industrial Engineering and Management
Logistics

**Master's Thesis**

# Wireless Applications Evaluation and Development Process: Case -Paper Industry Logistics

The subject of the thesis was approved by the council of Industrial Engineering and Management on the 12th of December 2001.

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## Abstract


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| **Keywords:** Wireless Application, E-business, Innovation Process, Paper Industry, Supply Chain Management, Radio Frequency Identification |
| The convergence of e-business and mobility together with the escalating pace of technological innovation are driving businesses to explore new wireless business solutions. The objective of this thesis was to study the process of evaluating and developing wireless e-business applications. The focus of the study is on the use of radio frequency identification in delivery tracking in the paper industry's outbound logistics.<br><br>The study defines the concept of wireless e-business and its value drivers, describes the different application areas and the strategic and technological dimensions of evaluating and developing wireless applications. The study provides a framework for examining the effects of wireless technologies on logistics.<br><br>The result of the study is a process model for evaluating and developing wireless applications. The delivery tracking application developed with the model proved to be beneficial for managing the supply chain. |

## Tiivistelmä

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| **Tekijä:** Antti Mikko Sissonen<br><br>**Työn nimi: Wireless Applications Evaluation and Development Process: Case -Paper Industry Logistics** | |
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| **Hakusanat:** Wireless Application, E-business, Innovation Process, Paper Industry, Supply Chain Management, Radio Frequency Identification | |
| Sähköisen liiketoiminnan ja mobiliteetin konvergenssi yhdessä teknologisen innovaation kiihtyvän vauhdin kanssa ovat saaneet aikaan kiinnostusta langattomia liiketoiminta-ratkaisuja kohtaan. Tämän diplomityön tavoitteena oli tutkia sähköisen liiketoiminnan langattomien sovellusten arviointi- ja kehitysprosessia. Työ keskittyy tarkastelemaan paperiteollisuuden toimitusketjun langatonta seurantaa.<br><br>Tutkimuksessa esitetään langattoman sähköisen liiketoiminnan määritelmä, kuvaillaan langattomuuden eri sovellusalueita ja sovellusten arviointi- ja kehitysprosessin strategisia sekä teknologisia ulottuvuuksia. Työ luo viitekehyksen, jonka avulla tarkastella langattomien teknologioiden merkitystä logistiikassa.<br><br>Tutkimuksen merkittävin tulos on prosessimalli sovellusten arvioimiseksi ja kehittämiseksi. Mallilla kehitetty langaton sovellus osoittautui tarkastelussa hyödylliseksi toimitusketjun hallinnassa. | |

## Foreword

The experience of making this Master's Thesis come true has been an enlightening one. It has given me a chance to put into practice all the sweat and elbow grease that I have faced in the academic world. At the end of the day I also feel that the past months have multiplied the knowledge gathered from years of studying. Experience is what I have gained, of both life and work, but especially the experience of going through this episode together in a fine esprit de corps with our eclectic and brilliant project group. I would like to thank the project manager Petteri Laaksonen for the excellent job he did of steering the ship and my supervising professor Anita Lukka for all her guidance and advice.

So, do I feel that I have truly attained a degree of mastery? Has this accomplishment met my expectations? I can say that my eyes are open now. Friedrich Nietzsche has said that "we have reached mastery when we neither mistake nor hesitate in the achievement". If I am not mistaken, I hesitate to say that the expediency of the challenge has not been achieved.

- Antti Sissonen

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# 1. Introduction

Three dominant factors can be seen as drivers of the new economic revolution. These are the emergence and convergence of e-business and mobility, the escalating pace of technological innovation and the shift from supply chains to demand chains. (Kalakota and Robinson, 2001, p. 105) These three factors are the central themes of this master's thesis.

## 1.1 Background and Research Problem

What are the forces behind the convergence of e-business and mobility that drive the emergence of wireless e-business? What should be the response to the rapid innovation cycle of the mobile industry in the current economic situation? What is the story behind the surfacing strategic role of the supply chain? Shortly, what is the background of the factors that drive the economic revolution? These issues shape the research gap that needs to be filled.

### 1.1.1 The Convergence

According to forecasts both mobility and e-business are facing significant growth. Although in certain parts of the world the mobile phone market development is reaching a saturation point at around 85%, a forecast by Analysys estimates that the number of people using mobile phones will continue to grow rapidly and will, by far, exceed one billion in 2005, whereas fixed Internet usage will develop at a substantially sedate rate. "Even with more optimistic forecasts of Internet users of up to 500 or 600 million worldwide by 2005, mobile penetration is likely to remain significantly greater." (Bond and Williams, 2000, p. 20)

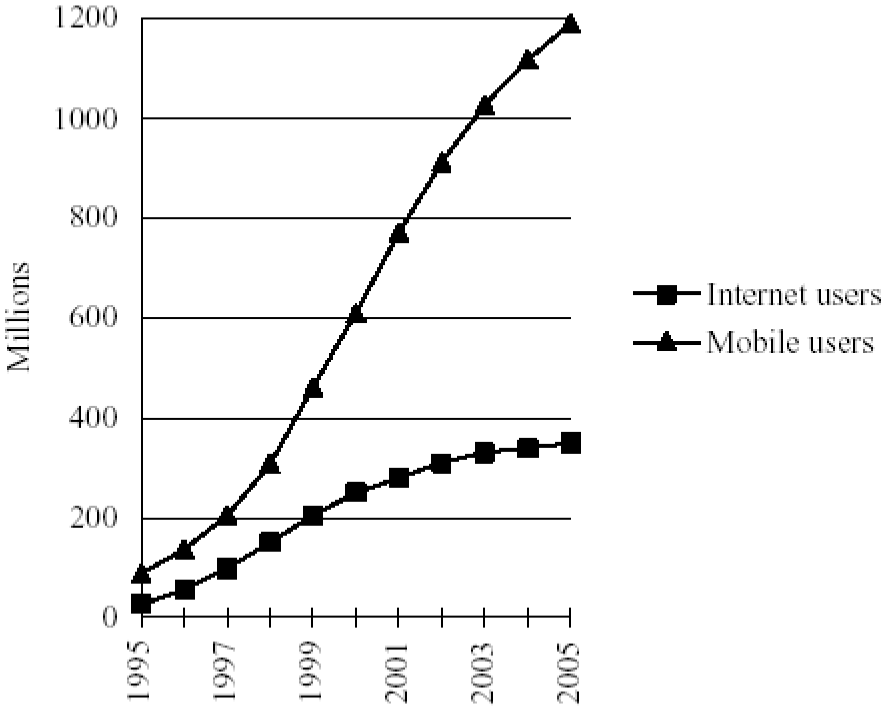


Figure 1. The development of mobile and Internet users. (Bond and Williams, 2000, p. 20)

However, the explosion in mobile phone usage alone doesn't necessarily result in the success of wireless e-business. Also a large number of mobile users need to use their mobile device to surf the Internet wirelessly. "By 2003, there will be more mobile handsets accessing the Internet than PCs." (Paavilainen, 2001, p. 44) According to ARC Group the number of mobile Internet users worldwide will exceed 920 million by 2006. This will be noticeably more than the number of fixed Internet users at that time. (Parker and McQueen, 2001, p. 228) These and many similar, albeit a bit more careful and possibly even more realistic forecasts by Yankee Group, Gartner Group, IDC, and others indicate that the convergence of mobility and the Internet is certain. (Smith, 2000) "The convergence of the Internet and wireless has irreversibly altered the value chains, profit opportunities, relationships, and indeed the very nature of the wireless industry." (Shosteck et al., 2000, p. 5) How is this going to change the way in which business is conducted, for instance in paper industry?

### 1.1.2 Mobility and Innovation

"The innovation cycle of the mobile Internet is very fast because of the immature nature of the mobile devices and networks. Developing mobile applications in an environment like this is challenging because the companies have to take into consideration the migration path to the next version" (Paavilainen, 2001, p. 56) Being continuosly innovative is indispensable for a company to stay competitive. The early mover advantage comes from acquiring important experience from the user requirements and patterns that enable brand success stories well known from the Internet. "Early movers will be able to shape markets, develop industry standards and gain market share." (Davison et al., 2000, p. 10) Then again, being the first necessitates considerable investments that, more often than not, produce less than the expected turnover. That is why it is important to be able to innovate and evaluate different options and then to select the right ones in which to invest.

"In today's economical situation companies are more interested in finding out how new mobile solutions can increase efficiency and bring savings to the current business processes, rather than finding new mobile business opportunities." (Snellman, 2001, p. 2) In other words, incremental business process improvements are preferred for now, before there is room for radical business concept innovation. What kind of innovation process would suit such a technological environment and economic situation?

### 1.1.3 Wireless Supply Chain Management

The supply chain management has been in the state of transformation. Its role as an operational tool has changed to one where its strategic dimensions are noticed and exploited. Transparency, responsiveness and the availability of end user information is called for throughout the supply chain. Can mobility and wireless e-business applications provide new answers and add strategic features to the supply chain structure?

### 1.1.4 Research Problem

The occurrences explained above have created a research gap that this master's thesis attempts to fill. A key question that emerges from the research problem and that requires answering is:

> *How can the strategic and technological attributes of wireless e-business applications be effectively and efficiently evaluated?*

More specific issues that are considered in relation to the key question are: How is wireless e-business and its value drivers defined? How can wireless applications be classified? What are the most important strategic and technological attributes? How will wirelessness change the supply chain structures? The objectives of the study, which lie within the limitations that have been set for the study and the project, can be derived from these open issues.

## 1.2 Objectives and Scope

The main objective of this study is to explain the process of evaluating and developing wireless e-business applications and, thus, provide an answer to the research problem presented above. In relation to this, the study aims to give an understanding of how the adoptation of wireless technology can change the supply chain structures and increase the dynamics of an organization. Moreover, the study seeks to react to the important implications and changes that this wireless phenomenon brings to the business.

### 1.2.1 Scope

The scope of the study keeps closely to what is defined in the project specifications notwithstanding some exeptions. The project and its delimitations are presented in the chapter 2. The scope of the thesis is defined as follows:

- Business sectors: business-to-business & business-to-employee,
- Business cluster: paper industry,
- Business function: outbound logistics,
- Innovation process: early phases, incremental improvements,
- Technology: wireless, especially Radio Frequency Identification.

### 1.3 Structure of the Study

The study follows the customary structure of a thesis. Two core sections are the theoretical and empirical contemplations of the topic. Notable emphasis is placed on the theoretical section.

The study has been carried out as a preparatory part of a two year project, which will undoubtedly lead to even further projects by the participating companies. Thus, no full or even partial end results could be expected at this stage of the project. The purpose of the thesis is to prepare theoretical grounds for the rest of the project and other future studies of the subject. The empirical part concentrates on explaining the implementation and use of evaluation and development process and introduces an example application. A more thorough explanation of each chapter is presented in a form of an input-output diagram.

#### 1.3.1 Input - Output Diagram

The diagram expands upon the matter of the structure of the study by defining the inputs and expected outputs of each chapter.

Table 1. Input-output diagram of the thesis structure.

| **Input** | **Chapter** | **Output** |
|---|---|---|
| - background & motives<br>- objectives and scope<br>- structure<br>- terminology<br>- methodology<br>  - literature review | **1. Introduction** | - evoking interest<br>- rationale for research<br>- thesis overview<br>- defining the subject<br>- used tools<br>- sources, availability |
| - presenting the project<br>- innovation process<br>- paper industry structure and charactericts | **2. Context**<br>*(Specifying the theory in relation to settings)* | - thesis as a project segment<br>- bigger picture<br>- the importance of logistics, product variety, future trends |

| | | |
|---|---|---|
| - value and market drivers<br>- multichannel approach | **3. Wireless E-Business**<br>*(Preparatory theory)* | - the wireless quotient<br>- the supplementary role of mobility |
| - business applications overview<br>- vertical-horizontal approach<br>- mobility dimensions | **4. Wireless Applications**<br>*(Preparatory theory)* | - the most beneficial segments<br>- alternative way of grouping<br>- effects of mobility |
| - application, key attributes<br>- strategic considerations<br>- technological issues | **5. Wireless Application Development**<br>*(Core theory and how it is applied)* | - ideal application's features<br>- strategic objective setting<br>- technology analysis |
| - logistics analysis framework:<br>  - conceptual levels<br>  - supply chain<br>  - costs trade-offs | **6. M-Logistics**<br>*(Theory for analysing the expected effects)* | - the effects of wireless applications on logistics<br>- pervasive supply chain<br>- cost savings |
| - charting wireless technology landscape<br>- idea evaluation<br>- technology sets<br>- presenting the case<br>- effects on logistics<br>- SWOT -analysis | **7. Empirical Part** | - technology mind map<br>- device database<br>- from 50 to 10 ideas<br>- choosing technologies<br>- delivery tracking<br>- transparent, pervasive SCM, costs savings<br>- summary |
| - wireless application evolution<br>- new business models<br>- environmental perspective | **8. Future Visions** | - looking further<br>- impacts on business and nature<br>- topics for supplementary study |

| | | |
|---|---|---|
| - content of the study<br>- conclusions | **9. Summary** | - assessing the value of the study<br>- summary |

### 1.4 Terminology

The terminology, including all the major definitions, is gathered under this subchapter where it can be easily found whenever needed. The definitions are divided into logical groups that are innovation, wireless e-business, wireless applications and their development, m-logistics, and future visions. All the acronyms appearing in the study are listed in the appendix V.

#### 1.4.1 Innovation

**Innovation Process**. "Any system of organized activities that transforms a technology from an idea to commercialization." (Souder, 1987, p. 5-6) However, the limitation of the study to the B2B sector renders unnecessary the claim for actual commercialization, since most of the applications are developed for internal use.

**Lead User**. Those who display two characteristics with respect to a novel product, process, or service: Lead users face needs that will be general in a marketplace, but they face them months or years before the bulk of that marketplace encounters them, and Lead users are positioned to benefit significantly by obtaining a solution to those needs. (Von Hippel, 1988, p. 107)

**Technology-Push**. Technology is seen as a driving force of innovation, cf. Market-Pull.

**Analytic Hierarchy Process**. An organized framework that allows for interaction and interdependence among factors, that effect the decision, and still enables the decision maker to think about them in a simple way. (Saaty, 1999)

### 1.4.2 Wireless E-Business

The concept of wireless e-business has several layers. In order to fully comprehend the meaning of the term, the definitions for e-business, m-business, mobile, mobility, and wireless are given here. These definitions have been created and agreed upon within the project to assure the integrity of the research. Unless specifically mentioned, the definitions below are from the research report "Content and Methodology Specifications of the Wireless e-Business Project" (2001). The following figure illustrates the definition of wireless e-business. Each term in the figure is further explained below.

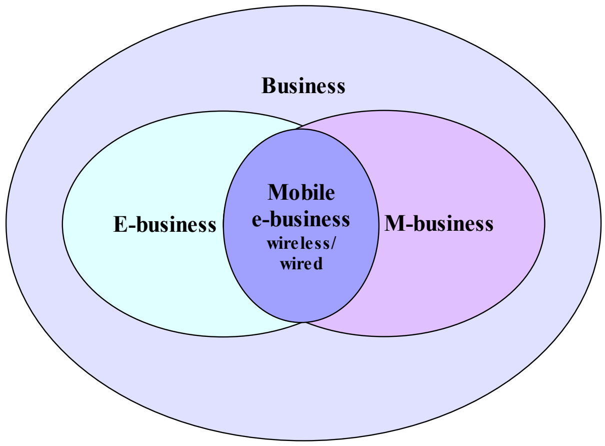


Figure 2. The definition of wireless e-business.

**E-business**. "Any ***Internet initiative*** - tactical or strategic - ***that transforms business relationships***, whether those relationships be business-to-consumer, business-to-business, intra-business, or even consumer-to-consumer." (Hartman et al., 2000, p. xvii)

**M-business**. Any *mobile initiative that adds demonstrable value*, whether it directly results in the generation of profit or not. Traditional voice calls are not included, but services using voice recognition in order to enable commercial transactions belong to the definition.

**Mobile e-business**. Mobile e-business is a *combination of e-business and m-business*. Mobile e-business solutions can be accessed over the Internet using physically connected or wireless devices alike.

**Mobile**. Something that can be used in any place where access is available, something that can be transported and connected to a network in different locations using wired or wireless access.

**Mobility**. Mobility is defined as the possibility to be connected and get access to a network using a mobile device in different locations, thus offering flexibility and transportability to the user.

**Wireless**. Wireless expands the definition of mobile: mobile and always online. (Kalakota and Robinson, 2002, p. 9) Wireless is defined in this project as the access to network or Internet-like services in any place without wires or cords using some kind of standard radio network. Also, mobile phones can be defined as being wireless devices as they themselves do not need any wires or cords to obtain access to a network.

In literature, wireless is mostly associated with short-distance radio technologies that provide local access to a network.

**Wireless e-business**. Wireless e-business is a subset of mobile e-business. It covers only e-business solutions that can be accessed wirelessly.

**Value driver**. A Performance variable that creates the value of the business. Value drivers have diverse levels of detail. (Copeland et al., 1994, p. 97)

**The Wireless Quotient**. Describes how relevant a wireless channel is as the medium for delivering a certain application. The most successful applications are likely to be those with compelling advantages in terms of all the concepts included in the wireless quotient. These concepts include ubiquity, intimacy, time-sensitivity and location awareness. (Advani et al., 2001, p. 45), (Paavilainen, 2001, p. 11)

### 1.4.3 Wireless Applications Development

**Application**. Performs a task to provide services for an end user. Often, an application is concisely viewed as a software running on a server or a handset. (Andersson, 2001, p. 10) This thesis employs a broadened view according to which an application includes everything from the demand (end-customer) to the source (content). The study focuses on applications that are aimed at wireless networks and devices i.e. wireless applications.

**Business-to-Business (B2B)**. Business activities between business units, companies, manufacturers, resellers (distributors, wholesalers, etc.), institutional, professional and governmental organizations. Purchases and sales to or from private consumers are excluded.

**Business-to-Employee (B2E)**. Business activities that involve organizations and their employees. Purchases and sales are carried out in the role of employee or employer. The seller and the purchaser can be within the same organization or in different organizations that have business relations (e.g. health care services).

**Machine-to-Machine (M2M)**. Wireless data connections between two machines, of which other can be a mobile.

**Multi-Channel (MC)**. An aggregate of vertical channels (networks, devices, services) for providing applications unlimitedly.

**Portal**. A world wide web site that is or proposes to be a major starting site for users by aggregating a wide variety of content, services and resources in one. (Tomsen, 2000, p.192) For example Yahoo! -portal.

**Data Mining**. A decision support process in which patterns of information are searched in data. (Parsaye, 1996)

**Open Mobile Architecture Initiative**. An initiative launched by Nokia, which aims at a global and open mobile architecture and the use of a common service platform. Firms such as AT&T Wireless, NTT DoCoMo, Telefonica Moviles, Vodafone, Fujitsu, Matsushita, Mitsubishi Electric, Motorola, NEC, Nokia, Samsung, Sharp, Siemens, Sony Ericsson, Toshiba and Symbian have announced their commitment to products and services based on open mobile architecture enablers, which signifies that they will develop mobile software in full compliance with the specifications set by the key industry standardization organizations. (Nokia, 2001)

**Hype Cycle**. A model that illustrates how the perceptions of the people tend to be distorted in the early development phases of a technology before it reaches maturity. The phases are technology trigger, peak of inflated expectations, trough of disillusionment, slope of enlightenment and plateau of productivity. (Gartner, 2001a)

**Value Proposition**. Crafting a solution to create value for the customer. Value proposition focuses on value creation, articulates strategy internally and externally, highlights the very source of competitive advantage and also allows employees to distinguish between value creating and non-value creating activities. (Kaul, 2000)

### 1.4.4 M-Logistics

**Logistics**. “Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements.” (CLM, s.a.)

**Supply Chain Management**. “Supply Chain Management is the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole.” (CLM, s.a.)

**Electronic Supply Chain**. The implementation of e-business solutions across the supply chain to redefine its structure into one that is more efficient.

**Responsive Supply Chain**. Integration of the supply chain in terms of demand and supply management driven by the need to respond quickly to the requirements of customers. (Hughes et al., 1998, p. 95)

**Demand Chain**. Enhances the importance of pull driven consumer demand instead of supplier push.

**Efficient Consumer Response**. A mechanism to translate pull driven consumer demand into efficient supply through integrated retailer-supplier systems. (Hughes et al., 1998, p. 148)

**SCOR –Model**. Supply Chain Operations Reference model that describes supply chain processes and defines measurement tools that make the comparison of supply chains possible.

**Intelligent Supply Chain**. Defining the whole supply chain as an intelligent and transparent inventory.

**VIPRO –Project**. A project aspiring to develop the paper industry's export processes by rendering the supply chain more proficient and cost-effective. The companies involved include Steveco, Stora Enso, Finn-carrier, Transfennica, Myllykoski Paper, UPM-Kymmene and VR Cargo. (Riikilä, 2000)

**Visibility**. Putting the right information into the hands of personnel engaged in supply chain management, planning, and execution. "Visibility unlocks hidden pain points in the supply chain that cause service failures and drive up costs. Visibility from procurement to customer delivery enables proactive supply chain management and avoids reactive, after the fact problem management." (Sapiens, 2000, p. 2-3)

**Delivery Process**. “The process of delivering the consignment to the consignee at the agreed time and place.” (ELA, 1994)

**Forrester Effect**. Supply Chains of physical goods often exhibit an increasing variability of orders in the downstream direction. Demand propagation from the customer to previous stages experiences some distortions and disruptions, which leads to an increasing amplification of orders. (Weber, 2001)

#### 1.4.5 Future Visions

**Business Model**. Depicts the content, structure, and governance of transactions designed to create value through the exploitation of business opportunities. (Amit and Zott, 2000, p. 8) Alternatively business model can be simply defined a as business concept that is put into practice. (Hamel, 2000, p. 66)

**Business Concept Innovation**. The capacity to imagine dramatically different business concepts or drastically new ways of differentiating existing business concepts. (Hamel, 2000, p. 66)

**Reverse Logistics**. The concept is applied in processes connected with recycling, reusing and reducing the amount of materials used.

**Porter Hypothesis**. Driven by the regulations to innovate environmentally fit products and processes, there is a possibility of simultaneous pollution alleviation and productivity benefits.

### 1.5 Methodology

This study uses qualitative case study approach. The nature of the used case study is exploratory since the wireless e-business applications can be considered to be a novel phenomenon and the specific example application used in the study is not yet a reality. The study attempts to analytically combine exploratory research of wirelessness with the descriptive theory of innovation process and logistics in order to create new extended theory, i.e. a model for evaluating and developing wireless e-business applications for paper industry's supply chain management.

An arsenal of research methods were applied throughout the study to gather, structure, and analyze data. Two techniques that were utilized in gathering information were interviews and a literature study. The next subchapter provides a thorough review of the quality and availability of literature sources. Decision support systems, such as the analytic hierarchy process and decision trees were used to structure the data into a more manageable form. Also, the mind mapping technique was applied to organize the information on wireless technologies.
A specific model was designed in order to describe the framework in which the study was carried out, i.e. the application evaluation and development process. The model is loosely based on R. G. Cooper's (1997) model of the early phases of the innovation process. Analysis tools, such as logistics pyramid conceptual model, SCOR model, logistics costs trade-off analysis, and SWOT were utilized in different parts of the study to evaluate the results and to provide answers. Each research method is explained in more detail in the study.

### 1.5.1 Literature Review

The availability of relevant and topical information sources is an issue that always surfaces when carrying out research into exploratory topics such as e-business and mobility. This study is, by definition, such a topic and, thus, the quality of material needs to be carefully assessed. The importance of the Internet and research organizations as information sources tends to be rather significant at the cost of conventional literature. The rapid continual transformation in the field that is being studied here generates the risk of the material becoming outdated. Journal articles are usually quite topical, but the articles go rarely beyond a general discussion of the subject. These are some of the reasons why it is important to maintain a critical approach towards the material at hand. On the other hand this may also result in the lack of available sources.

It is worth asking how the issue of confined information availability can be overcome. The study of analogies between the research and more traditional somewhat parallel topics is necessary. E-business has changed the world, and it could, therefore, be asked what wirelessness will contribute in relation to the changes brought about by e-business. Comparisons with different fields of business such as automotive industry, retail or business-to-consumer sector in general might also open up new possibilities. B2C sector has been used in some parts of the study as a comparative entity to B2B and B2E sectors.

As was mentioned earlier, the use of the Internet may be emphasized in studies such as this one. Although the organization and the rules that govern information delivery in the Internet have been essentially developed, there still exist obvious problems. The authenticity of the information and the primary source can be hard or impossible to confirm. To avoid this dilemma, only recognized sources such as well-known Internet publications and research organizations should be used.

Research organizations and their reports have an important role as information sources in implementing studies of this kind. Durlacher Research Ltd., Gartner Group, IDC, Yankee Group, Frost & Sullivan, Mobile Insights and Tekes are all good examples of institutes that have studied the field and periodically provide up-to-date research results. As a result of the project's research effort the shared article database includes more than 1600 documents. Of these, more than one hundred research reports and white papers were studied extensively for this thesis. Still, one must not forget criticality. Many of these are profit-making organizations, and there is always a possibility of bias due to the involvement of different interest groups.

In spite of all the issues cited above, there are also some excellent books available that have provided good insights to this study.

**Innovation**

The innovation process study of the thesis relies strongly on Cooper's Winning at New Products (1997) that presents the stage-gate model and defines the early phases of innovation process. This book is also used in Master's Thesis by Matti Laaksonen (2001), which goes deeper into the subject and, as a parallel holistic study, is used as a basis for research into the innovation process section of this thesis. Other books, that have provided assorted perspectives on the topic for this thesis, include Seeing Differently: Insights on Innovation by J.S. Brown (1997), Managing New Product Innovations by W.E. Souder (1987), The Sources of Innovation by Eric von Hippel (1988), Revolutionizing Product Development (Wheelwright and Clark, 1992), and Managing Innovation (Tidd et al., 1997).

**Wireless E-Business**

Mobile Commerce Strategies (2001) by Jouni Paavilainen takes a good look at the mobility and wireless e-business in general and provides a strategic approach. Andersson's GPRS and 3G Wireless Applications (2001) and Wireless Internet Enterprise Applications by Chetan Sharma (2001) take a very technological approach to wireless applications. Content & Applications for the Wireless Internet by (Parker and McQueen, 2001), in addition to presenting a market analysis, also has a strategic outlook and provides some foresights on the topic. In their new book Kalakota and Robinson (2002) discuss the mobile internet and m-business from the business perspective. Business Agility by Nicholas Evans (2002) presents strategies for gaining competitive advantage through mobile business solutions.

**Supply Chain Management**

The employment of E-business in supply chain management has been studied immensely. Nonetheless, literature that would concentrate on mobility and wireless technology usage in SCM is almost non-existent. The books by Paavilainen (2001) and Kalakota and Robinson (2002) briefly touch on the issue. The following books have provided the grounds for understanding the development of the SCM and e-business: Transform Your Supply Chain: Releasing Value in Business (Hughes et al., 1998), E-Business 2.0: Roadmap for Success (2001) by Kalakota and Robinson. The Logistics Handbook (1994), an extensive compilation by Robeson and Copacino had a supportive role in logistics part of the study.

# 2. Context

This chapter discusses the context in which the study was conducted. The owner of the study, the Telecom Business Research Center, is briefly introduced; the project is presented to provide an understanding of the entirety of the research. The role of application development as a part of the innovation process is described. It is important to understand how, for instance, industry structures set their own specific frames for studying wireless e-business. The structure of the paper industry is examined. Some of the special characteristics of the industry have created a clear demand for adding mobility to certain business functions.

## 2.1 Presenting the Project

This thesis was carried out as a part of a research project 'New business models arising from the convergence of the E-Business and Mobility in the USA and Europe'. This section was written as a joint effort project publication. (Sissonen et al., 2001)

### 2.1.1 Background

The convergence of the IT and Telecom markets is creating completely new ways for companies to operate. The application of new technology in so-called old industries will make the Infocom sector boom. The time window for utilizing an innovation into a new business has shrunk and business-to-business e-commerce sales are developing and growing very fast. Mobility, widely understood, opens a completely new way for companies to apply e-business in their operations.

### 2.1.2 Scope

The research program concentrates primarily on business-to-business and business-to-employee segments and compares the markets in Europe and in the USA. The companies studied here are large industry leaders and their suppliers. The chosen industries are the ICT (Information and Communications Technology), paper, and retail industry. Program focuses its company cases in Finland and in the USA.

### 2.1.3 Research Targets of the Program

1. *To create a competitive Wireless E-Business research team* in Finland and link it firmly to research in the USA.
2. *To produce comparative research results between the USA and Europe* in the application of Wireless E-Business.
3. *To enhance the cooperation between* universities in *Finland and the USA*.
4. *To apply modeling technologies,* such AHP and real options, into forecasting the market development of the Wireless E-Business.
5. To study the *new business models that arise from the usage of Wireless Applications*.
6. To define the *scenarios for the development paths* of *E-Business* in *Europe and the USA* and derive alternative future outcomes.
7. To study and *model,* from the Service Operator industry perspective, *the industry restructuring* of selected industry sectors due to changes brought about by the convergence of mobility and e-business.

### 2.1.4 Business Targets of the Program

1. To recognize the *main benefits or opportunities* for the companies in so-called old industries.
2. To analyze and forecast the *speed of change, time-to-market and growth opportunities*.
3. To analyze the *risks* or hindering factors, "stumbling stones" that may delay or halt possible development.
4. To define the *required enabling technologies and services models.*
5. To analyze the opportunities for *new types of business models and changes* to exiting ones.
6. To *forecast or build scenarios* of the *industry structure* and the new roles of the companies.

### 2.1.5 Structure and Phasing

The project is divided into sub-projects, which are divided into separate research studies, coordinated within this program. The project structure is depicted in the figure below. This thesis was done as a part of the technology evolution and the application opportunities sub-project (circled in the figure). The Thesis' relations to other studies conducted in the project are illustrated in more detail in appendix VI.

Firstly, the program concentrates on analysing the present situation and strategic trends, which offer new business opportunities and enable new business models. New application models are created by using the lead user method and technical configurations and requirements are planned. New applications are analysed with a "Return on investment" approach. The methods used include ROI, AHP and Real Options.

The second phase of the program focuses on the psychological and learning aspect of the application of the above-forecasted technology and service diffusion and concentrates on taking a new outlook by finding the reasons for the decreased rate of application of technology in organizations.

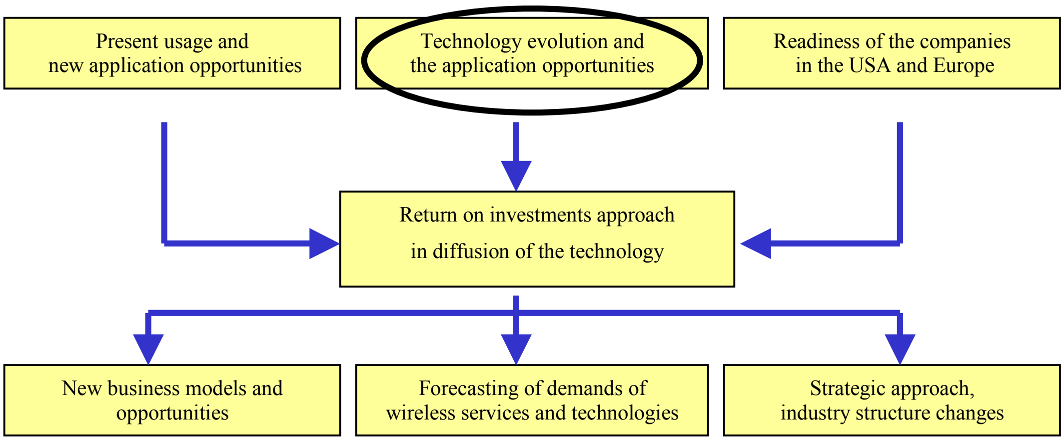

Figure 3. The structure of the project. (Sissonen et al., 2001)

### 2.1.6 Telecom Business Research Center

Telecom Business Research Center (TBRC) is a research unit in Lappeenranta University of Technology. It was established in 1999 as an interdisciplinary consortium of several departments: Business Administration, Industrial Engineering and Management, Information Technology and Electrical Engineering and Electronics. The focus of the TBRC projects is the Telecom and Information Technology industry. The main aim is to forge a link between university researchers and industry. In order to do this, research groups focus on specific managerial problems and challenges. The staff of TBRC consists of the university personnel. Some people from cooperating companies work in TBRC, which enables the fast and effective connection with partners. Research teams are usually of a multidisciplinary composition and consist of researchers from different fields such as business administration, information technology, telecommunications and logistics. Such an interdisciplinary approach combines knowledge in technology with that in economics and enables high-quality multidisciplinary results.

## 2.2 The Bigger Picture

The evaluation and development of applications should be studied as a part of innovation process that spans from the driving forces of the innovation (market-pull and technology-push) to the implementation of the application. A clear challenge in innovation is trying to control the co-evolutionary process where both driving forces, markets and technologies, are emerging. (Brown, 1997, p. xiii) This is especially true for the emergence and convergence of e-business and mobility where the changes in markets and in technologies are exceptionally impetuous. This study emphasizes the technological aspects at the expense of markets since the scope is limited to the B2B sector where the direct effects of market-pull are somewhat limited.

According to Cooper (1997), the early phases of innovation process are idea generation, initial screening and preliminary investigation. Preliminary investigation is comprised of three parts: market, technical and financial assessment.

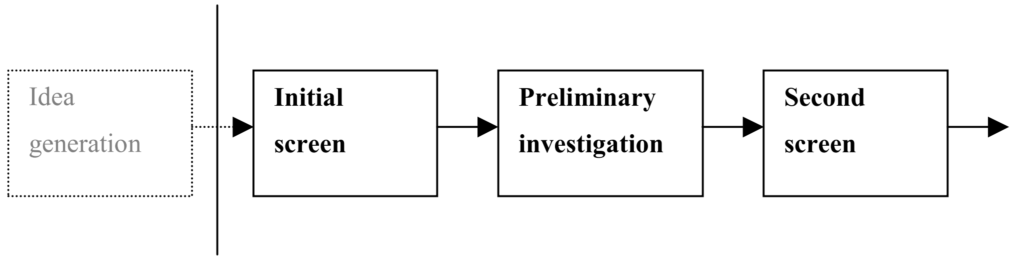


Figure 4. The phasing of the innovation process. Adapted from (Cooper, 1997, p. 108)

Cooper's (1997) model consists of gates that screen the ideas and stages that gather further information for developing and evaluating the ideas. Therefore the initial screening process for example is the first gate of Cooper's model.

### 2.2.1 Evaluation and Development Process Model

"Research has repeatedly shown that firms that lack a strategy for innovation and simply innovate on impulse are poor performers." Experience suggests that some form of structured development system with clear decision points and agreed rules on which to base the decisions, is needed. (Tidd et al., 1997, pp. 244-251)

This thesis introduces a new process model for evaluating and developing wireless applications. (Sissonen et al., 2002, p. 4) The empirical part of this thesis uses the developed model as a framework for studying wireless applications. The model includes elements that relate to Cooper's (1997) initial screening and technical assessment phases, but also beyond the early phases. Similarly, the model consists of certain stages and gates. The figure below demonstrates the basic setup from which the development of the process model was started.

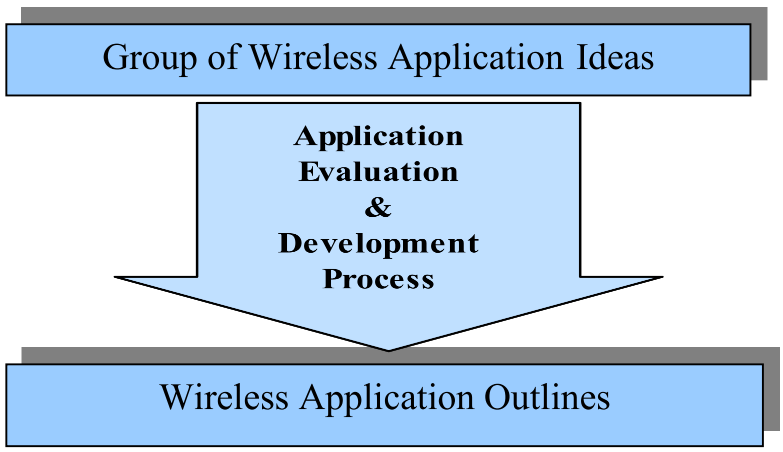


Figure 5. The basic setup of the thesis research gap.

The developed framework has also been influenced by the innovation management process model that is presented in the book "Managing Innovation". (Tidd et al., 1997, p. 41) Tidd's model contains a strategy phase that includes activities such as:

- linking with overall business strategy,
- linking with core knowledge base (competencies),

- the assessment costs and benefits of different options and
- the selection of priority options.

These activities are also taken into account in the  model introduced in this thesis.

The master's thesis of Matti Laaksonen (2001) provides the project with a more extensive study of the innovation process. The financial assessment stage presented in the Cooper's (1997) model is comparable to the studies in the master's thesis of Auri Määttä using the Real Options approach and the market assessment stage, which is particularly B2C sector oriented, correlates somewhat with the readiness research of the project. The next subchapter takes a more specific theoritical look at initial screening and the steps of technological evaluation in the model. An overall explanation of the model and its steps are given in the empirical part of the study.

### 2.2.2 The Process of Screening and Evaluating Ideas

The process of developing a new application or a product begins with coming up with a group of ideas from where the best ones need to be chosen for further development. The key issue is to decide what ideas are the most prominent ones for development into actual applications that will be not only profitable for the company, but also beneficial for the customer. Here, a trade-off must be made between gathering enough information for decision-making and actually making swift decisions. How can all the critical factors be taken into consideration when choosing to which supposedly top ideas the company should direct its scarce resources?

In an ideal situation, the decision-maker has immediate access to perfect information on all the ideas, i.e. they are fully developed into working applications that are tested and used. This would eliminate the risk of dropping off an idea that, at first sight, seems poor but, in the light of perfect information, turns out to be excellent. The limiting factor, which makes the ideal situation impossible, is the availability of the company's resources, especially that of time and money.

"The screening of new product ideas is perhaps the most critical new product development (NPD) activity, yet it often is performed poorly. [..] The manner in which a company evaluates new product ideas has tremendous implications for the overall success of the new product program and the company's performance." (Calantone et al., 1999, pp. 65-66) Weak projects not only result in lost investments but also represent significant opportunity costs because they prevent other product ideas from being developed.

"The importance of the screening activity is reflected in the fact that new product screening is one of the most frequently undertaken NPD activities, and, more importantly, it is highly associated with the ultimate performance of the product in the market. Interestingly, past research has found that managers do not perform the screening activity proficiently." (Calantone et al., 1999, pp. 65-66) Some of the things that the managers should consider when screening ideas are an application's suitability for an organization's mission and objectives, the level of application's innovativeness, the development costs, the chances for success in the market, the level of profitability, the available resources and so on.

Sophisticated management science tools, such as computer software, have been developed to assist managers in decision-making process for the choice of the right idea, but their use have not been widely adopted. Studies have shown that informal procedure was most often used for screening and that only 21% of the firms used management science techniques for making screening decisions. (Cooper and Kleinschmidt, 1986), (Dwyer and Mellor, 1991) One possible tool to use in the idea screening and evaluation is the Analytic Hierarchy Process, which is briefly introduced below.

### 2.2.3 Analytic Hierarchy Process

The analytic hierarchy process is an organized framework that allows for the interaction and interdependence among factors, which influence the decision, while still enabling the decision-maker to view these factors in a simple way. "Basically the AHP is a method of breaking down a complex, unstructured situation into its component parts; arranging these parts, or variables, into a hierarchic order; assigning numerical values to subjective judgments on the relative importance of each variable; and synthesizing the judgments to determine which variables have the highest priority and should be acted upon to influence the outcome of the situation."

(Saaty, 1999, p. 5) Figure 6 illustrates the hierarchic structure that is used in AHP decision-making. To reach a predefined goal, the alternatives are evaluated according to groups of criteria and sub-criteria.

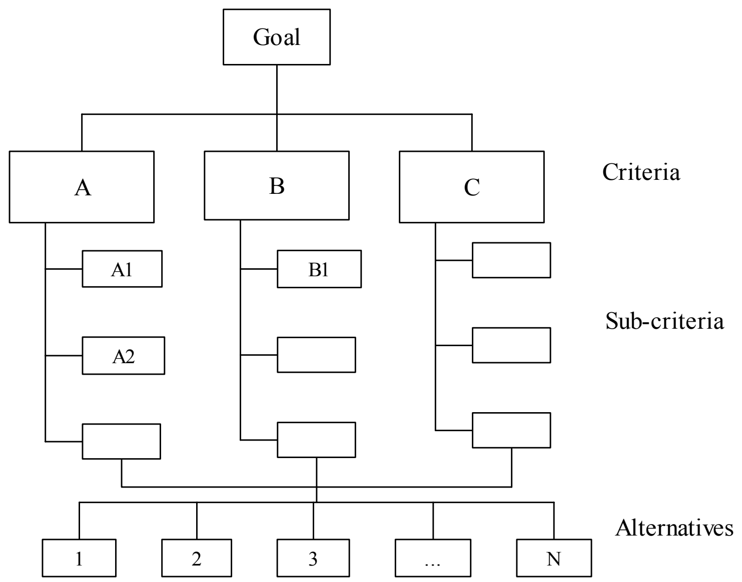


Figure 6. The hierarchic structure for decision-making in AHP. Adapted from (Saaty, 1999, p. 63)

The AHP rests on three principles of explicit logical analysis: the principles of constructing hierarchies, establishing priorities and logical consistency. It is natural for humans to organize the information into hierarchic groups and levels and also to perceive relationships among them. Human thought is also capable of comparing ideas in such a way that they are coherent or logically consistent. The advantages of the AHP include:

- **Unity**; provides a single, flexible model for a wide range of unstructured problems.
- **Complexity**; integrates deductive and systems approaches in solving complex problems.
- **Interdependence**; eliminates the need for linear thinking, and enhances the interdependencies between elements.
- **Hierarchic Structuring**; reflects the mind's natural way of structuring.
- **Measurement**; provides a scale for measuring intangibles and a method for establishing priorities.

- **Consistency**; tracks the logical consistency of judgments.
- **Synthesis**; leads to an overall estimate of the desirability of each alternative.
- **Tradeoffs**; takes into consideration the relative priorities of factors in a system and enables people to select the best alternative based on their goals.
- **Process Repetition**; enables people to refine their definition of a problem and to improve their judgment and understanding through repetition.
- **Judgment and Consensus**; does not insist that consensus be reached. (Saaty, 1999, p. 25)

Thomas L. Saaty developed the AHP framework in the 1970s.

### 2.2.4 AHP in Idea Evaluation

The process of evaluating applications can be extremely complex and often requires the manager to consider several criteria and their relative effects and importances simultaneously. “Without decision support, managers are likely to make their decisions based on only a subset of important criteria (e.g., expected net present value and fit with manufacturing technology), while not understanding their relative weights and interactions. The AHP thus makes the decision process more rational by taking all the data given by the manager and synthesizing them in a way that the manager might not be able to do by him/herself due to the limited cognitive ability of the human mind.” (Calantone et al., 1999, p. 69) The empirical section of the study introduces an AHP –model developed particularly for this research project.

## 2.3 Paper Industry Structure and Characteristics

Two well realized theses of the project (Suikki, 2001), (Hiltunen, 2002) provide an excellent basis for the contemplation of the paper industry in this study. The key issues are brought forward here to give an overview of the context that paper industry provides for wireless e-business applications.

### 2.3.1 Paper and Board Products

Paper and board industry is a subdivision of the chemical forest industry sector, whereas the mechanical forest industry sector consists of sawmill, wood plate, plywood and other wood product industries. Paper and board products are among the most important sources of income in the forest industry. (Juslin and Neuvonen, 1997, p. 52)

Paper is not a bulk product. On the contrary, there are many different product grades, from bulk to speciality, with numerous variations. Customers demand highly customized products and, thus, a large portion of the deliveries consist of MTO - production. This explains the high complexity of the order-delivery process in the paper industry sector. Besides the price level, quality, technical service, and delivery time are important competitive factors. (Diesen, 1998, p. 62) The employment of wireless technologies offers to improve all of the above factors.

### 2.3.2 The Importance of Outbound Logistics

Raw material has always been an essential necessity in forest industry and, thus, in Finland the wood procurement process is well developed. Examples of this are the high tech harvesters with wireless telecommunication features and the utilization of GPS technology. In recent years forest industry companies have invested heavily in ERP (Enterprise Resource Planning) systems in order to manage effectively the supply chain. In other parts of the supply chain, the use of wireless technologies has been limited.

To be a competitive player today in Finnish forest industry, requires efficient delivery logistics, since all the major markets are abroad. (Juslin and Neuvonen, 1997, pp. 53-56) For example roughly 95% of the paper deliveries of a certain Finnish paper manufacturer go abroad and 75% of this to EU. (Aaltonen, 2002) A typical supply chain, that reaches from forests deep in Russia, through Finland to the South of the EU, is long and complex. The order-delivery process needs to be developed to the same high level as has input logistics. The employment of wireless technologies can offer many improvements that help the paper industry to reach the goal of effective delivery.

### 2.3.3 Future Trends in Paper Industry

Some of the issues that will drive the development of the industry are consolidation, price and market development, environmental issues, shareholder value and increase in demand. In contrast to expectations, electronic communication has seemed to increase the paper demand. In the future this trend will most likely reverse as the technologies and routines develop further.

Some of the future trends that seem to emerge from the above challenges are digital printing, M2M solutions, and decentralization of production. Development in customer awareness requires faster and more flexible delivery processes. E-business, on the other hand, has not reached a significant role in forest industry. Electronic marketplaces have not succeeded, since paper manufacturers want to control the supply chain themselves. In order to achieve interactive and integrated supply chain, new concepts for production, products and demand management will be called for and wireless technologies will enable applications that bring solutions to all of these areas. (Hakala, 2001, p. 33)

# 3. Adding Wirelessness to the Business

"Wireless data is highly successful in many business applications today. Using wireless has significantly improved worker productivity, increased customer satisfaction and, in many cases, provided a competitive advantage." (Broadbeam, 2000, p. 3) This chapter discusses the nature of wireless e-business value drivers. Hence, a brief introduction to the concept of value driver is given here. The multi-channel approach is analyzed to demonstrate that, in spite of its vast significance, wirelessness should still be considered to be an addition to existing communication channels.

## 3.1 Defining Value Drivers

Value drivers are factors that improve the performance of a business. (Paavilainen, 2001, p. 135) Copeland (1994) uses a very similar definition for value drivers, but adds more dimension to it. Value drivers have diverse levels of detail. A certain field of business, such as wireless e-business, has generic value drivers that make it special and distinct from others. However, from the specified business level, each company and even business unit must derive their own more detailed value drivers. "Value drivers must be defined at a level of detail consistent with the decision variables that are directly under the control of line management." (Copeland et al., 1994, p. 91) One must also attempt to distinguish between internal and external value drivers.

## 3.2 Wireless E-Business Value Drivers

"Ubiquity, intimacy, time sensitivity and location awareness are the key concepts that make the mobile business so different from 'traditional' e-commerce." (Paavilainen, 2001, p. 11) These concepts are the main drivers that define the wireless quotient of an application; in other words, how relevant is the wireless channel as the medium for delivering a certain application? The most successful applications are likely to be those with compelling advantages in terms of all the concepts included in the wireless quotient.

Table 2. The wireless quotient. (Paavilainen, 2001, p. 11)

| **The Wireless Quotient** |
|---|
| Ubiquity |
| Intimacy |
| Time sensitivity |
| Location awareness |

The expression wireless quotient is introduced in the Business Strategy Review article ‘Making the Most of B2C Wireless’ where the time- and location-sensitivity are discussed more profoundly. According to the article, mobile access is needed especially when activities being performed are either time-critical or time-killing. Time-killing refers to a situation where user has a few spare minutes and nothing to do. “Similarly, users have most to gain from wireless either when their exact location matters (location-critical) or when a wired connection is not available, even though a wired version of the application might be better (location-killing).” (Advani and Choudhury, 2001, p. 45)

A few words must be said to clarify the connotation of ubiquity and its difference from location awareness and time sensitivity. Ubiquity highlights the independency of the wireless application usage in relation to time or place. Location awareness or sensitivity conversely demonstrates how the wireless application can exploit the location information to enhance the experience. Another value driving feature of wireless e-business, which fits under the definition of ubiquity, is instantaneous usability. (Bond and Williams, 2000, p. 9) Wireless devices are usually always on and on-line, or at least the boot up and the access formation are fairly quick in comparison to those for PCs.

The high level of personality that mobile devices possess is the reason for the personal customization that the wireless applications need to have. For its part, the intimacy defines what kind of applications are rational in wireless environment. “Making the applications user-centric as opposed to technology-centric is crucial.”

(Andersson, 2001, p. 294) This aspect of the wireless quotient is especially highlighted in B2C sector, but affects the B2B side as well.

On an organizational level some possible wireless e-business value drivers that can be derived from the wireless quotient are improved human performance, fast inventory turnover, reduced inventories, cost saving and productivity. (Paavilainen, 2001, p. 135)

### 3.2.1 Market Drivers

Wireless e-business value drivers were discussed above. In contrast, there are market drivers that affect the diffusion of the technology and increase the interest towards the wireless solutions in the industry. Some of the market drivers that make things happen in the businesses are

- Market pull:
    - a rapidly rising number of mobile workers,
    - increasing customer awareness and acceptance,
    - the level of Internet penetration and purchases in the market,
    - the development of partnerships between the players,
    - declining prices,
    - competition,
- Technology push:
    - the availability and performance of infrastructure (networks, devices),
    - the emergence of wireless content and service providers,
    - increasing amount of middleware and other software solutions
    - rationalization of the industry standards, and
    - regulatory issues such as 3G licensing and spectrum allocation, which evidently can work both ways.

(Broadbeam, 2000, pp. 10-11),(Sharma, 2001, pp. 25-16), (Barbero, 2001, p. 10), (Davison et al., 2000, p. 10), (Evans, 2002, pp. 36-37)

## 3.3 From Mobile to Multi-Channel Business

"We believe that m-commerce in the closed sense will not survive as a stand-alone business model. Instead, we expect to see the rise of multi-channel commerce (i.e. MC-Commerce), which will include a significant proportion of revenues from mobile commerce. [..] Portals and most applications will have to incorporate a multi-access approach." (Müller-Veerse et al., 2001, p. 5) "The goal of multichannel solutions is to deliver the appropriate content, to the appropriate users, through the appropriate device, at the appropriate time, and in the appropriate way." (Advani and Choudhury, 2001, p. 49)

### 3.3.1 Synergy and Challenges

The strengths of each communication channel should be emphasized. On the other hand, the multi-channel approach also enables the compensation of each channel's limitations. "A mobile channel is able to provide time sensitive and intimate content regardless of the location of the handset owner. The fixed Internet can be used for filling long forms, viewing images, reading product specifications and many other tasks hard or impossible for a mobile device." In the same manner, printed media, TV and other communication channels add to the convenience of the multi-channel approach. (Paavilainen, 2001, pp. 116-127)

"Adding a mobile channel to existing channels such as the Internet poses a variety of challenges for the implementer of a mobile solution. [..] A significant number of multichannel architectures will need to be completely redesigned in order to integrate the mobile channel successfully." (Datamonitor, 2000, p. 39) "Multi-access portals enable customers to access a wide variety of personalized services through a variety of communication channels. [..] The most important driver for a multi-access portal strategy is the fact that customers need access to their services and applications from any device, at any time, from any location. The challenge is to optimise the user experience (determined by device, access channel and the type of service and/or application). Additionally, portal owners need to understand how their users move across different access channels and devices. When new type of access devices, channels and methods emerge, portal owners need to be able to quickly integrate them into their portal platform." (Müller-Veerse et al., 2001, p. 44)

### 3.3.2 Multi-Channel Evolution

The first step in the evolution towards multi-channel pervasive business was the convergence of Internet and traditional business. The user reaches a new communication experience level as m-business adds yet another channel. The future can be seen as a ubiquitous communication environment where access is possible absolutely anywhere at anytime.

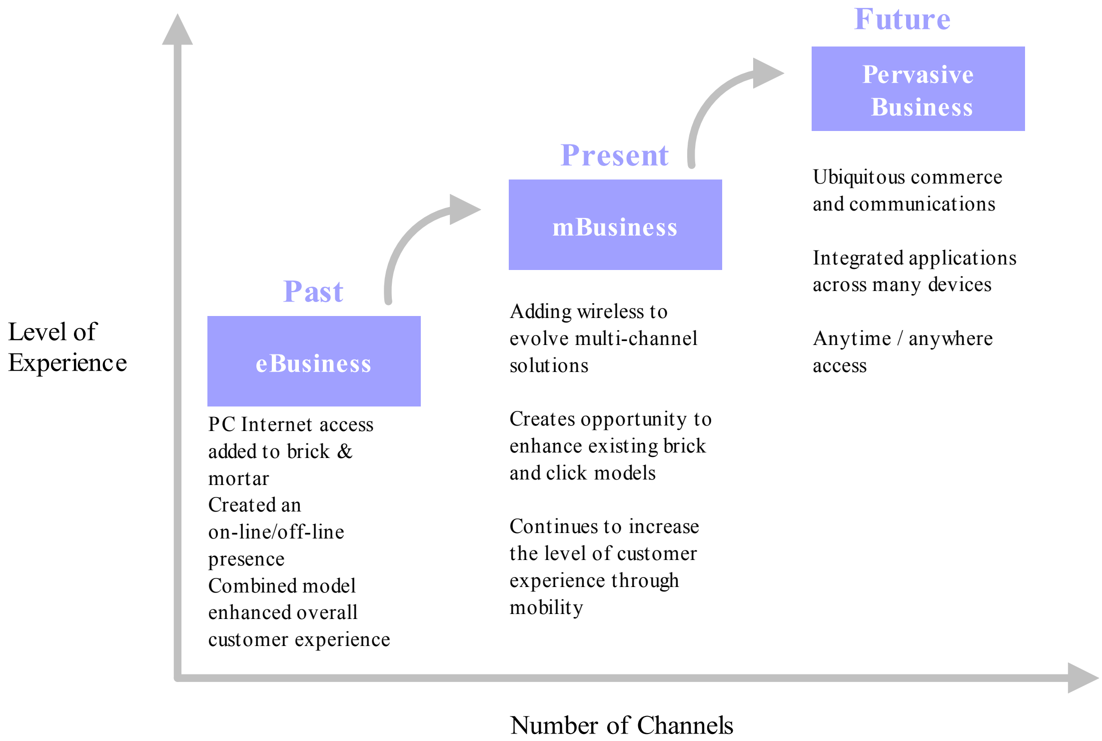


Figure 7. Multi-channel evolution. Redrawn from (Advani et al., 2001, p. 8)

Different types of portals using access methods such as mobile phones, speech recognition, PCs and laptops, and set-top boxes will be merged to form a multi-access architecture.

# 4. Wireless Applications

“Applications have always existed to assist businesses to achieve competitive advantages in terms of saving costs or realizing revenue opportunities. Mobile technologies have the potential to enhance an organisation’s processes and interfaces by making them available anywhere at any time.” (Müller-Veerse et al., 2001, p. 105)

Application performs a task to provide a service for an end user. Often, an application is concisely viewed as a software running on a server or a handset. (Andersson, 2001, p. 10) thesis takes a broadened view, according to which an application includes everything from the demand (end-customer) to the source (content). This includes such entities as devices and networks, user interface, mobility management, and enabling services like security, billing, and location-based services. The rest of this chapter defines three basic frameworks for studying the nature, characteristics and different dimensions of wireless applications.

## 4.1 An Overview of Business Applications

Three major segments of the business applications defined by the Durlacher Ltd. are customer relationship management (CRM), supply chain management (SCM) and workforce applications. The research predicts that these are the segments that will benefit the most from the mobility.

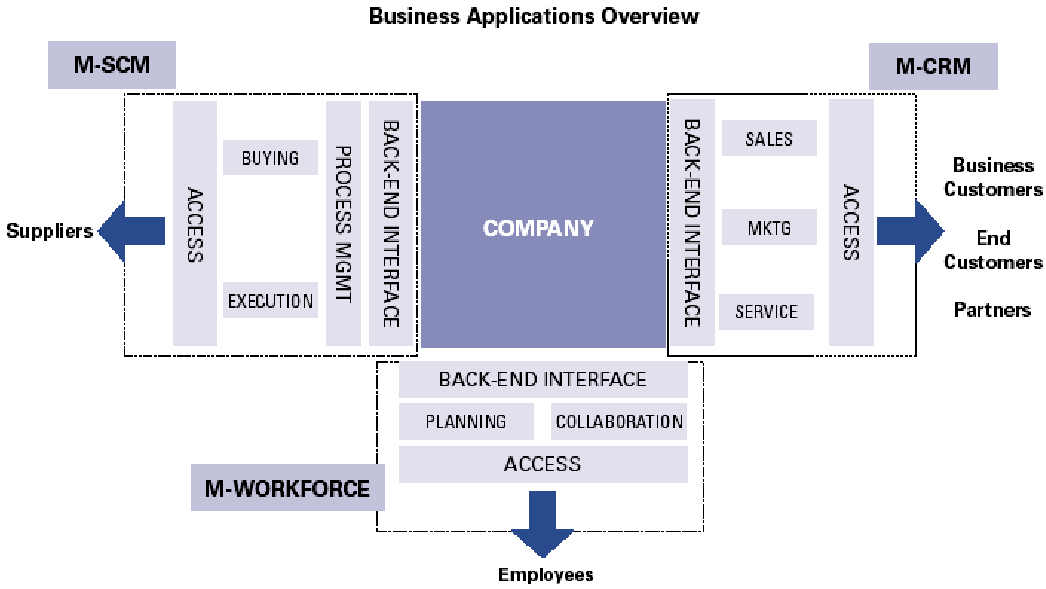


Figure 8. Segments that will benefit the most from mobility. (Müller-Veerse et al., 2001, p. 105)

Although the applications are divided in the model according to interest groups that the application targets, the diagram does not attempt to illustrate a company value chain or network in itself. It only points out that the wireless application's characteristics can differ from one another depending on the interest groups at which the application is targeted. Although information sharing should be transparent throughout the company's value network there is a definite demand for a 'need to know' approach. In order to avoid information overflow, transparency should attempt to concentrate on sharing information that is especially relevant to each group that interfaces the company.

### 4.1.1 Mobile Customer Relationship Management

M-CRM solutions are designed to provide partners, business and end-customers with a mobile interface for company functions such as sales, marketing and service.

### 4.1.2 Mobile Supply Chain Management

M-SCM solutions are aimed at making the supply chain more integrated and transparent by creating wireless gateways to SCM systems, increasing the data collection possibilities and enabling mobile alert generation and real-time ubiquitous information sharing. The logistics and the supply chain management are discussed more intensely in their own chapter.

### 4.1.3 Mobile Workforce

The function of M-workforce applications is to facilitate the communication of business processes to mobile employees. Such mobile office functions for example are the typical PIM (Personal Information Management) applications like calendaring, scheduling and collaboration applications built around a wireless messaging interface. A self-evident example of a mobile employee, who requires a wireless connection to company systems, is a sales person..

## 4.2 Vertical – Horizontal Approach

One method of grouping the application landscape is to define vertical and horizontal target groups. "Vertical targets are typically narrow user segments, such as field service engineers or sales representatives. Horizontal applications are meant for a massive number of users." (Paavilainen, 2001, p. 138) The following diagram combines the three vertical segments defined by Durlacher with several horizontal applications.

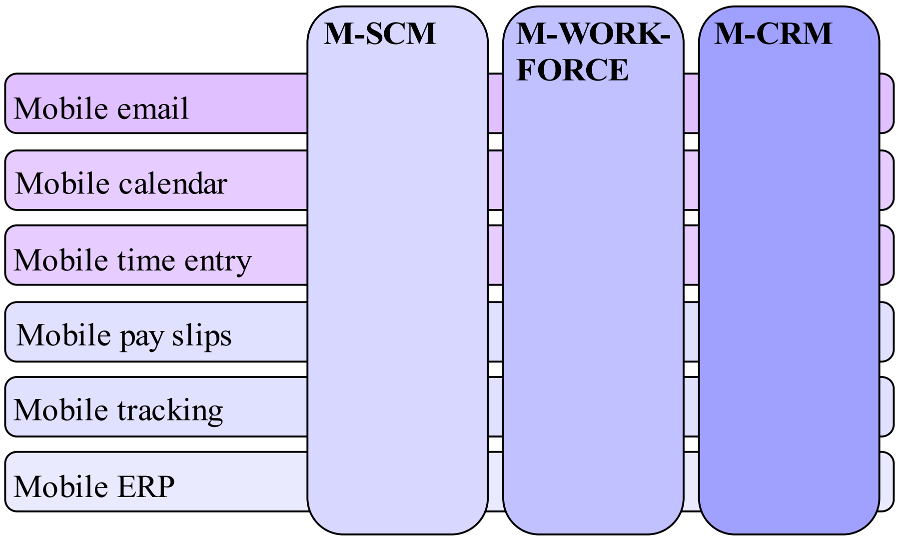


Figure 9. Vertical and horizontal applications. Adapted from (Paavilainen, 2001, p. 139)

Not all the horizontal applications apply to all three vertical categories. Mobile pay slips for example would be used only in B2E sector. The first four horizontal applications are typical PIM applications.

### 4.3 Mobility Dimensions Approach

Wireless applications, as a rule, have increasing effect on the mobility of the business. Mobility and its effects vary depending on whether the application is used in the office, on the road or by the third parties. The figure below presents four dimensions of change which define the nature of a wireless e-business application.

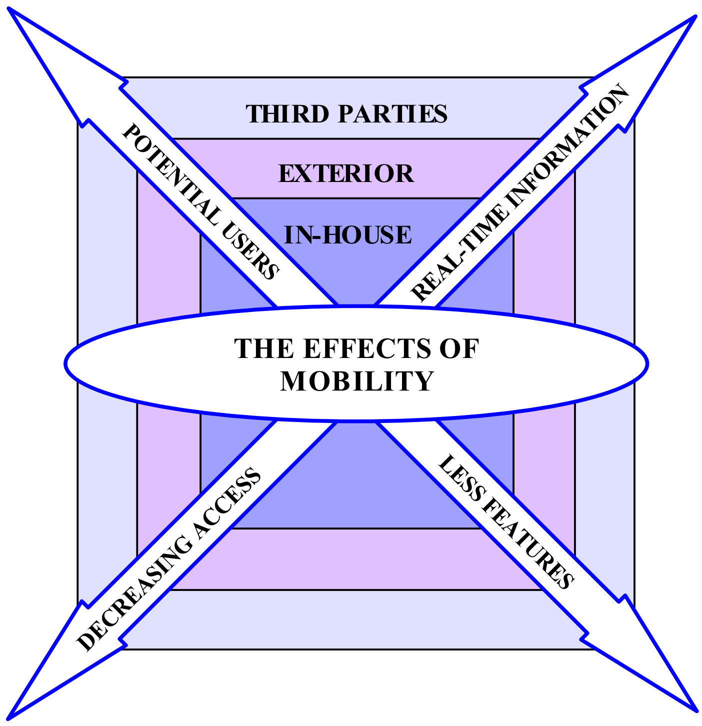


Figure 10. The effects of mobility in different dimensions.

In-house wireless e-business applications can be presumed to have several access options such as local fixed network, WLAN and Bluetooth networks, mobile phone networks (GSM, GPRS etc.) When using the same application out of office, the number of access possibilities decrease. Similarly, the application's features become limited due to restricted performance of the infrastructure. The bandwidths of wireless networks are limited, just as are the memory, input mechanisms, processing and battery power of wireless devices. This sets certain preconditions for the design of application.

The timeliness of overall information in the central system improves, since updates are possible not only in the office but anywhere at anytime. Then, of course the wider the availability of an application, the greater the number of potential users it has.

# 5. Wireless Application Evaluation and Development

This chapter forms the core theory of the study. It explores the strategic, technological, and timing issues surrounding the evaluation and development of wireless applications. The discussion begins with a portrayal of some key attributes of a good wireless application. Next, the chapter elucidates several reflections that help guarantee proficient end-results. Finally, the application architecture is discussed, a horizontally layered architecture framework and an adaptive application architecture reference model are introduced. The importance of testing and end user feedback for the process are examined. This chapter also takes a brief look at the development of wireless applications from the investment perspective.

## 5.1 The Key Attributes of a Good Wireless Application

What are the things that define a successful high-quality wireless application? If the wireless quotient is high, i.e. the wireless e-business drivers (ubiquity, intimacy, time sensitivity and location awareness) are present, the application will most likely succeed. Another answer to this question could be pervasiveness, immunity to security breaches, synchronous information, intelligence, and adaptability.

1. **Pervasive**. Distribute information when and where it is needed.
2. **Immune**. Built to ensure appropriate levels of security for varying degrees of information and application sensitivity.
3. **Synchronous**. Information must be refreshed continuously, rapidly, and remain accessible.
4. **Cognitive**. Must recognize the type of device on which it is being run, and use the fastest, most effective means of transmitting and receiving data. It must also be capable of intelligently compensating for screen size, slow bandwidth, dropped connections and limited storage.
5. **Ergonomic**. Must adapt to the user. People gain freedom and flexibility without having to reinvent the way in which they work. (mbrane, 2000, p. 3)

## 5.2 Strategic Considerations

“No organization should consider implementing mobile applications just because they are becoming more popular and common. The decision should be based on clearly identified needs and business requirements in order to create additional value and draw the company closer to the goals and objectives defined in their main strategy.” (Paavilainen, 2001, p. 134) Nevertheless, image value, i.e. exceptionally good visibility in the market, may justify investments in an otherwise strategically unsound mobile application. Moreover, a strategic approach, where only the core business is considered in the idea innovation phase, can have a very limiting effect on the results. Some good areas of improvement or especially new business concepts might go undiscovered.

“Additionally, the identification of value drivers is essential in order to explore the full potential of the new technology.” (Paavilainen, 2001, p. 135) “Identifying key value drivers can be difficult because it requires an organization to think about its processes in a different way.” (Copeland et al., 1994, p. 95) The wireless quotient was introduced earlier in chapter 3 where some company specific value drivers were also presented. Mobile applications have the capability of virtually integrating value chains: strategic partnerships between the different parties of the value chain can be strengthened. (Paavilainen, 2001, pp. 135-136) In his book ‘Mobile Commerce Strategies’ Paavilainen presents a structure for setting objectives in application development. In this way, value drivers and the strategic guidelines are properly perceived when defining the goals of the process. This ensures that the application serves the overall strategy of the company and that the value of the core business can be maximized.

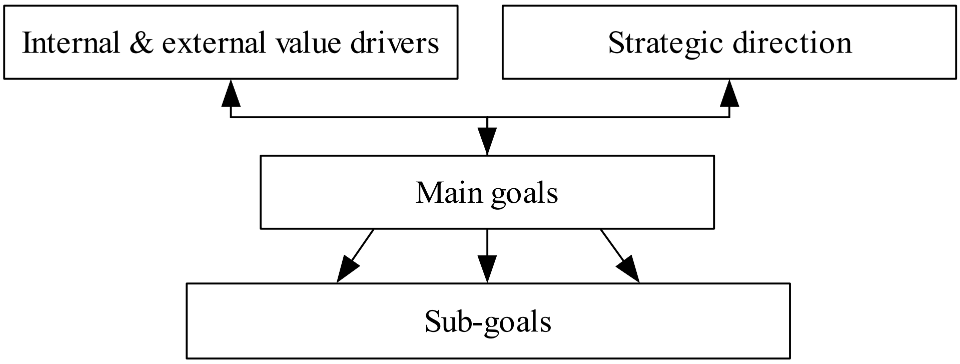


Figure 11. The structure of objective setting in application development. Adapted from (Paavilainen, 2001, p. 137)

The following table lists actions that should be considered in order to ensure the strategic fit of a wireless application.

Table 3. A tasklist for ensuring the strategic fit of an application. Adapted from (Paavilainen, 2001, p. 136)

| **Actions** | |
|---|---|
| **Value Drivers** | **Strategy** |
| ▪ Define the value drivers of the company<br>▪ Assess the impact of the new technologies to the value drivers | ▪ Define corporate strategy<br>▪ Understand the strategic context of mobile applications |
| **Competitors** | **Core Business** |
| ▪ Closely follow the actions of competitors | ▪ Define the core business and acknowledge the core processes |
| **Internal Processes** | **External Relations** |
| ▪ Based on the core business, define the most important internal processes<br>▪ Observe the processes to define gaps or opportunities<br>▪ Define internal value drivers | ▪ Define the gaps in relation to the virtual value chain integration<br>▪ Address the needs for enhanced communication<br>▪ Define external value drivers |

## 5.3 Technological Issues

"The technological infrastructure of the wireless Internet is proving to be even more intricate than that of its PC-based predecessor. The layers of complexity created by melding numerous disciplines are made infinitely more difficult to resolve by the lack of technological standards in key segments of the industry. While sorting through standardization options is a natural phase of technological development, the implications of this process for the wireless Internet are immense." (XSVoice, 2001, p. 6) In addition to lack of standards there are several technological issues that need to be considered when developing a wireless e-business application. The disconnected fashion of communication, the usage of multiple devices and several other things makes the wireless application development a very different paradigm from the standard procedure for the development of applications.

### 5.3.1 Information Delivery to Multiple Devices

Information delivery in wireless and wired environments differs greatly from each other. The mobile world calls for much more dynamic and flexible structure, i.e. cognitive system. Multiple mobile devices with different form factors such as limited screen size or input mechanisms set their own specific limitations. "Information should be delivered to these devices in such a way that it is very easy to read and respond." For example, an application should include many built-in standard responses that are a one-key operation and easy to use such as 'Job Complete'. (Broadbeam, 1999, p. 23)

Furthermore, an intelligent routing capabilities and unified messaging (UM) are required. "UM systems allow for a variety of access methods to recover messages of different types." (Parker and McQueen, 2001, p. 12) An application should filter or synchronize information appropriately for various devices that the user has. For example, a laptop and a mobile phone cannot necessarily receive the same kind of message or might ask for very different formats of the same message. Mobile data synchronization is an area where a great deal of progress can be expected. To replace the current proprietary solutions, open standards are being developed by SyncML, which is an open industry specification for universal data synchronization. "The plan is for easy synchronization between any device and application over any network. Interoperability between mobile devices and networks applications is enabled. The SyncML Initiative (www.syncml.org) was founded in February 2000 by Nokia, Ericsson, Motorola, IBM, Lotus, Palm, Psion and Starfish Software. There are more than 400 companies in the initiative, though Microsoft is one notable exception." (Parker and McQueen, 2001, p. 50)

Having multiple devices brings forward the issue of multiple addresses from which the user can be reached. "Mobile users want to access the same information from each device. They want information to be synchronized between devices. They do not want to maintain multiple addresses for different devices." (Broadbeam, 1999, p. 25) A UM system that has a common mail box for all message formats solves this problem. However, the application needs to be able to implicitly distinguish between different devices. The introduction of IPv6 (Internet Protocol version 6) broadens the address space and makes it possible for each device to have its own IP address. "The new IP will integrate all connected devices in the same address space, within a unified end-to-end architecture." (Müller-Veerse et al., 2001, p. 113) In short, a user will be able to have multiple devices but will only need one personal address to which messages can be sent.

The message priority, the profile and the current status of the user should also be taken into account. The most urgent messages should reach the destination first. If the same basic information is sent to several persons it should be formatted according to their profile. One user might prefer voice messages when the profile of another asks for pager contacts only. The profile can vary a great deal depending on the location or the time of day. One generally prefers not to receive work-related contacts during free time. (Broadbeam, 1999, p. 24)

### 5.3.2 Multi-Network Environment and Coverage

"Network coverage is continuing to expand but users will always experience coverage holes or fluctuations in coverage levels. [..] A variety of factors can influence coverage including rain, tall buildings, and hills and going deep inside a building. [..] A critical component of a successful mobile application is the ability to push data to users. Remember that mobile workers are operating in a disconnected fashion and often roaming in and out of coverage. Therefore, they cannot be expected to constantly check to see if they have any data or messages waiting for them. Information should be pushed to mobile users." (Broadbeam, 1999, p. 25)

In a similar way the device should be able to perform an automatic switch transparently from one connection technology to another when moving in a multi-network environment. The following figure from the Durlacher Ltd. research depicts a few possible scenarios of such a capability.

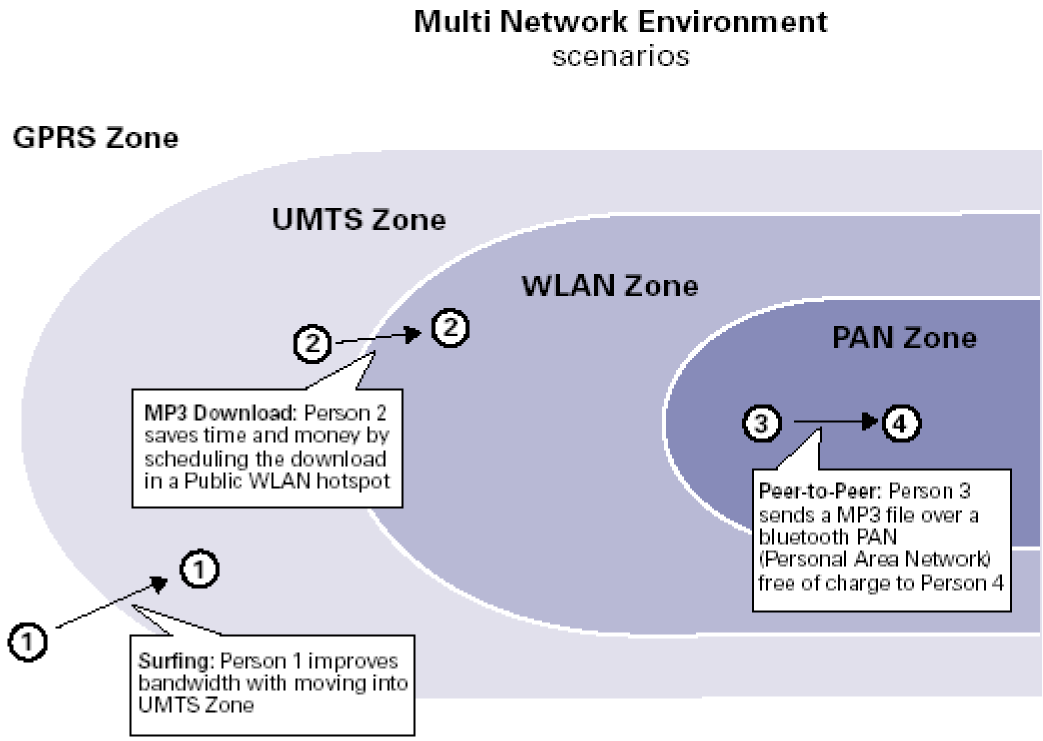


Figure 12. Moving from one zone to another. (Müller-Veerse et al., 2001, p. 58)

An environment, where multiple networks are transparent to the user, provides the pervasiveness that is called for. "It would be ideal that when the available bandwidth becomes higher, the terminals will automatically switch to the new technology and frequency band to take advantage of higher data rates. However, technologically it still remains a challenge to establish transparent hand-overs between different types of networks. The management of the hand-overs and different access charges associated with different network environments will require a reconnection when reaching the higher bandwidth network, or a harmonization of prices." (Müller-Veerse et al., 2001, pp. 58-59)

"One way to accommodate changing coverage is to implement store-and-forward message queuing. In this instance, messages are stored in a queue when the user is out of coverage or offline and then pushed to the other side once the connection is reestablished. [..] In order to improve performance, your application should also include optimizations that allow it to adjust automatically when coverage conditions are poor to retain the connection whenever possible." (Broadbeam, 1999, pp. 25-26) The re-start checkpoint is another very important factor in coping with the coverage fluctuations. An application needs to be able to resume an information transfer once the connection is re-established. The user's awareness of the application performance should be assured by providing them with real-time information. "For example, your application should let users know if they are in coverage so they don't waste valuable time and battery power attempting to continually resend messages or connect to the network." (Broadbeam, 1999, p. 27)

### 5.3.3 Dynamic Design

An application needs to be portable, scalable and backward compatible. An application's migration path and future plans need to considered. Since the technologies develop over time, the old technologies become obsolete while new ones arise, it is important to design adaptive applications. "As with all enterprise applications, scalability is an important factor in developing wireless applications. When designing your system, be sure to develop your application to be highly scalable and reliable." (Broadbeam, 1999, pp. 26-28)

### 5.3.4 Optimization Within the Constraints

The bandwidth and several device features set their limitations to wireless applications. The scarce bandwidth resources should be optimized. "First, data sent over the air should be compressed. Second, unnecessary headers and 'handshake' packets should be stripped out of the communication. Finally, the application should be designed to send the minimum amount of data over the air." (Broadbeam, 1999, p. 26) Often, the mobile working environment has some special characteristics.

“Mobile applications must be very easy to use and recover when problems occur. Due to the remote nature of mobile workers, it becomes increasingly difficult to provide troubleshooting and support when problems arise. Applications should be very robust and reliable to work well in the field.” (Broadbeam, 1999, p. 27)

The management of the processing, memory and power resources of a mobile device is another essential issue. “In a highly distributed environment such as mobile computing, thin clients are prevalent. Your client application should be designed so that the server does the majority of the processing. This paradigm follows the emerging paradigm of Internet computing. [..] Sending and receiving data uses battery power. Therefore, your application should be designed to manage the use of power. For example, it should send the minimal amount of data over the air. It should also have a ‘sleep’ mode during periods of inactivity to minimize the use of power.” (Broadbeam, 1999, pp. 27-28) The following figure summarizes the different functions that an operating system has to be able to manage as well as those that impose limitations on device performance.

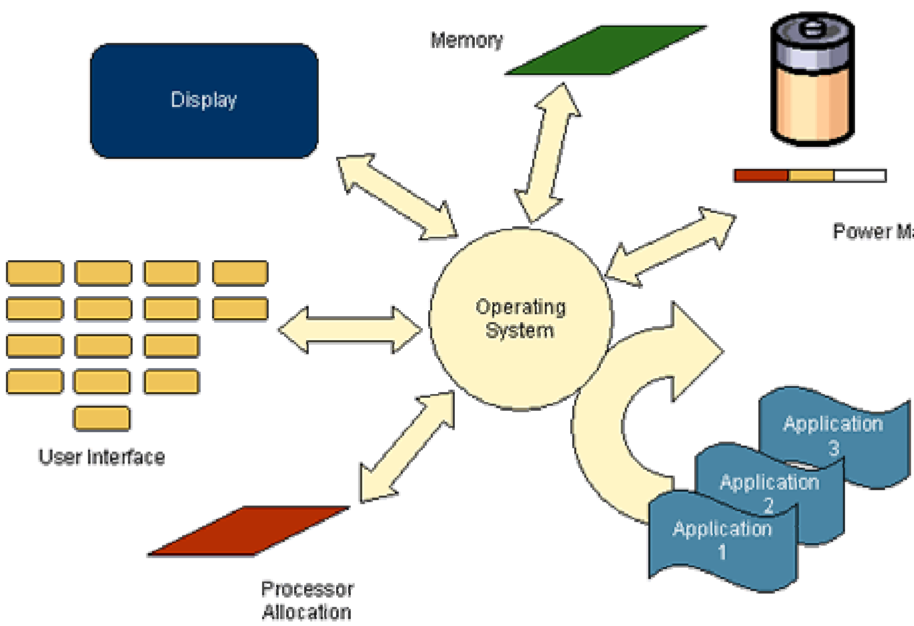


Figure 13. Operating system functions. (Sterling, 2000)

Four key features that define the application’s mobile friendliness can be derived from the issues of restrictions mentioned above:

- **Visuality**, is the process visually driven, does it require heavy graphical content?
- **Input Needs**, is it necessary to enter long arrays of text?
- **Complexity**, How many clicks or selections does it take to complete a task?
- **Duration**, How much time does the transaction take?

(Leung and Antypas, 2001, p. 12)

### 5.3.5 Network Management

Remote users are especially difficult to manage, monitor, troubleshoot, and support. "When developing an application, consideration should be given to how support staff can perform remote diagnostics and manage mobile users. Consider implementing a mobile network management product that will provide alerts and statistics, let your network managers know how many users are connected, how much data is being sent, how many messages are waiting, when users last connected, what network/device they are using and other such key data. Remote distribution of software updates is also a key issue for mobile applications. Unless mobile workers regularly come into the office with their computers, you will need to plan for how you will remotely distribute software upgrades to their devices." (Broadbeam, 1999, p. 28)

### 5.3.6 Security

Conventionally the wireless environment has been conceived as fairly safe with less security hazards known from the traditional world of computers and the open Internet. The both mobile network and device manufacturers have had closed proprietary designs that haven't attracted harmful adversaries. Also device-to-device network connectivity has been more controlled. Conversely the security protocols of some mobile solutions have been weak due to cut down of overhead in the name of bandwidth optimization. A small device is easily lost, stolen, or physically damaged due to the human factor.

All this is now changing. The first cases of virus infections in mobile phones have been recorded. The varied proprietary solutions are being standardized and the mobile Internet is emerging as an open platform very similar to its fixed antecessor.

This will also open doors to security risks. On the other hand the new standards enable common and strong security solutions and the increasing bandwidth allows the development of more extensive and tighter security protocols. VPN (Virtual Private Network) solutions over wireless network with reasonable latency are possible.

Radio waves do not stop to corporate walls or to other artificial borders. Thus a perimiter defense like a firewall familiar from the fixed LAN settings won't be sufficient in mobile world. Each end device must be secured individually, but the management must be centrally implemented. Some other things that can be done to increase the security of wireless networks and devices are remote antivirus updates, document deployment and troubleshoots to devices, and lock down and tracking of lost or stolen devices. The security issues of wireless e-business applications have been studied in this project comprehensively in the master's thesis by Olli Kytölä.

### 5.4 The Construction of Technology Combinations

An exceptionally essential part of the basic research required for the application development process is the charting of the availability of the different wireless technologies now and in the near future. This groundwork creates a knowledge base for the construction of wireless technology combinations that meet the requirements of each application that are chosen for further development. Several complicated decisions have to be made when choosing between the different available technology options. It may be very difficult to make multiple devices and technologies to work seamlessly together. "One often-overlooked issue concerns interoperability of handsets, portals, gateways and networks." (Parker and McQueen, 2001, p. 50) In this study a simplified decision tree model was used for the more problematical and intricate decisions. A basic structure of a decision tree is introduced in the figure below.

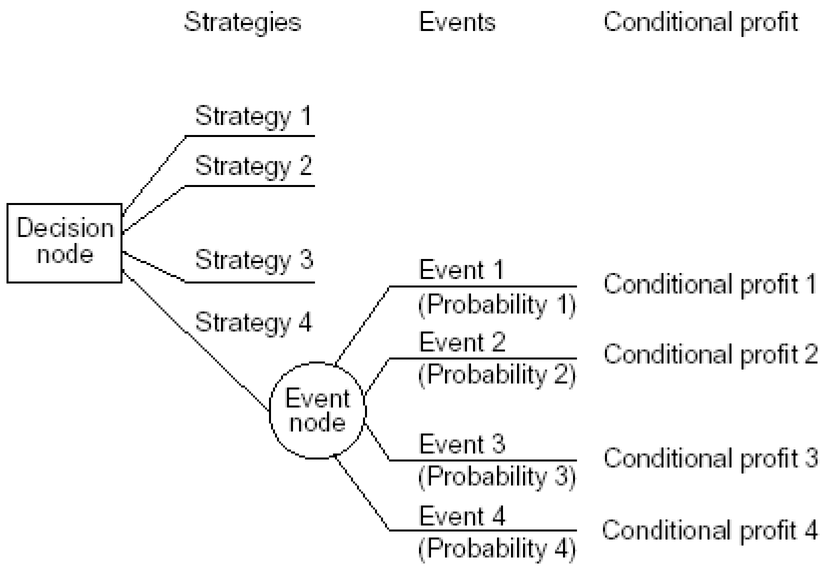


Figure 14. The structure of a decision tree. (Coles and Rowley, 1995, p. 46)

Decision trees have a built in capability of contemplating the future scenarios. For each decision there can be a number of events or outcomes with different probabilities and possible profits that might be realized.

## 5.5 Application Architecture

The way in which wireless applications are implemented could do with more harmony. Traditionally applications have been developed rigidly in technology-specific closed environments. The old overall application architecture consisted of parallel vertical applications that rarely were capable of interaction. E-mail was used in the fixed Internet using PCs that could not receive normal phone calls, while SMS messages could not be received on fixed phones. To assure interoperability and a functional multichannel environment, there exists, for mobile networks, a demand for an open and flexible application architecture to that is also secure and reliable. (Andersson, 2001, pp. 181-183)

### 5.5.1 A Horizontally Layered Architecture

A horizontally layered architecture provides a solution to the problem expressed above. It is comprised of three main planes that are applications, control and transport. In this way, the applications are transparently accessible, independent of the device or network that is defined already on the transport layer. Control layer takes care of the session management, synchronization, and security issues.

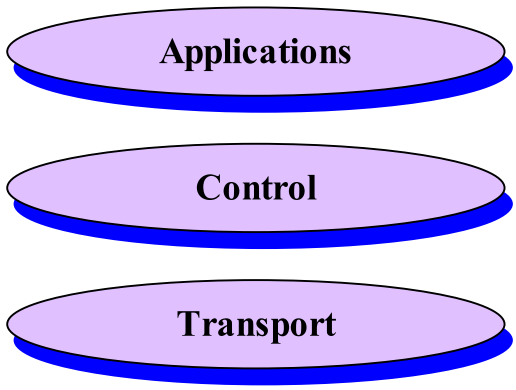


Figure 15. The layered applications architecture. Redrawn from (Andersson, 2001, p. 183)

The reference model decribed below takes the application architecture design one step further.

### 5.5.2 Adaptive Application Architecture

This subchapter introduces a reference model that makes a suggestion for the way in which the wireless applications should be set up. “Support for wireless access to IT systems clearly demonstrates the challenges of network computing: maintaining multiple mutating devices, unstable and mixed-media content, and multiple networks. Early attempts to build applications for specific content, devices and networks are doomed. Beyond this, creating generalized software platforms for wireless applications has largely focused on data transformation (often referred to as transcoding) between a server holding content or managing transactions and a wireless-connected, mobile, client device. This view is still too narrow. A complete model of the system requirements is needed.” (Hayward, 2000)

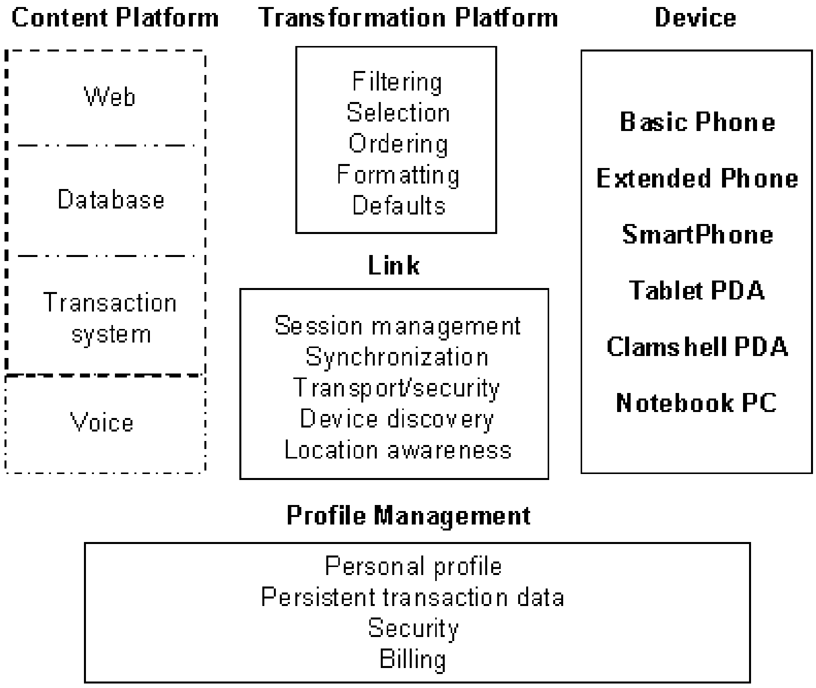


Figure 16. Adaptive application architecture. (Hayward, 2000)

The key elements of the reference model are generality of connectivity for content and device types, and the ability to handle different types of interaction. Any kind of content should be able to be accessed with any kind of device. The architecture consists of three logical components that make this possible:

- Link — the elements that manage the link (network transport),
- Transformation Platform — the elements that handle the transformation of the data stream, and
- Profile Management — the management of persistent data that supports the overall interaction.

The link and the transformation platform corresponds with the control and transport layers of the horizontal architecture model. In addition to conventional transport issues the link layer also includes the integration of data in regard the location of the device. “Data from the link layer and from the profile management provide inputs to the transformation process. This mediates between the content platform and the device, creating an interaction appropriate to the device and the user.” (Hayward, 2000) In this way, the information is provided in right format, at the right location, to the right device, when the user prefers to receive it.

### 5.5.3 Open Mobile Architecture Initiative

The industry has realized the need for open architecture. The initiative launched by Nokia at the Comdex Fall 2001 aims at this.

> *"An open and global services platform is of paramount importance for the industry in order to meet the expectations of our highly demanding customers and to boost innovation through independent software developers."*
>
> - Jorma Ollila, Chairman and CEO, Nokia

Several big players on the mobile market including Sony, NTT DoCoMo, and Motorola have already joined the initiative. To back up the initiative Nokia has promised to license its own service platform openly including the source code. (Nokia, 2001) Microsoft, a prime example of a closed standards company from the PC world, has not yet shown interest. The importance of the initiative is emphasized as we know how troublesome the development of the PC market has been.

## 5.6 Listening to End user

Designing wireless applications that are genuinely valuable requires a clear understanding of end user practices and needs now and in the future. (Sharma, 2001, p. 135) "The applications and initiatives may have good potential for return on investment, and be well planned architecturally, but without end user acceptance and adoption these initiatives can achieve far less than was originally intended." Whether they are employees, customers, suppliers, or partners, the end users need to have an input into the requirements gathering process and the functionality that the applications are enabling. (Evans, 2002, p. 23) The end user should be analysed in three dimensions: demographic profile, context and goals.

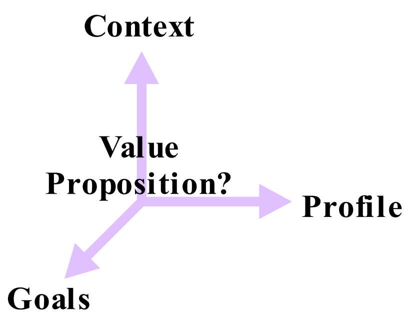


Figure 17. Assessing the real end user needs. Adapted from (Advani et al., 2001, p. 16)

The demographic profile is the traditional measurement tool of consumer behavior and provides information on user attributes. For a user of a wireless e-business application some profile attributes to be considered are education, computer and Internet literacy, motivation and personal expectations. The context defines a user's physical and technological environment: the wireless quotient of the task in which they use the wireless application. User goals refer to the specific reasons for which the user uses a wireless application. How does the user see their work routines and how could the particular application help in conducting them? "Before any of the mobility's benefits can be realized, it must become integrated with the user's way of doing things. Indeed, mobility's potential contribution can't even be envisioned until the solution has been fully adopted and used by a company's employees and customers." (Kalakota and Robinson, 2002, p. 262)

The analysis of the end user demand through these three dimensions provides the evaluation and development process with a value proposition that the application needs to be able to fulfil. Basically the wireless application value proposition must deliver the appropriate content, to appropriate users, over the appropriate channels, at appropriate times, in an appropriate way. (Advani et al., 2001, p. 16) However, it is not always certain that the end-user acknowledges their actual needs and what wirelessness can really offer. The gathering of information from the end-user about such a new phenomenon as wireless e-business applications needs to contain a strong educational component that creates awareness of an unknown value proposition..

### 5.7 Testing the Wireless Applications

Developing a test strategy is ever too often left at the final stages of the development process. However, it should be one of the first things to get started and should continue throughout the process. "The most difficult part of testing wireless applications is probably realizing what kind of testing you need and how to perform the testing." (Andersson, 2001, p. 267)

The following three test types are important when developing wireless applications.
Graphical User Interface (GUI) and usability testing, network performance testing, server-side testing. There are two basic methods of implementing the tests. Both

emulators and real networks and devices should be used in testing. Each method has its advantages and disadvantages and selecting a test is mainly a question of reaching a trade-off between the veracity and the cost of the test. (Andersson, 2001, p. 269)

## 5.8 Investment Perspective

What wireless technology or application will be worth the money? How can an investment be properly timed? "Gauging which portable wireless communicators will succeed in the marketplace is tricky at best. There are lessons to be learnt from earlier product introductions and the resulting growth curves. Historically, the best new products achieve a penetration rate of 50% in the first 10 years. [..] even the most successful products have started out very slowly in the first couple of years after introduction." (Parker and McQueen, 2001, p. 43)

The development of wireless technologies can be presumed to follow the Moore's law. The diffusion of PC market is a good, often used analogy when estimating the growth curves of other technologies. Thus far, it seems to be comparable with the sales and price development of mobile phones. "The cost of wireless devices and network usage is dropping fast. For example, the cost of a cellular telephone and the associated service has fallen significantly over the last 10 years. It is expected that this trend will continue. As the cost of wireless devices and services drop, the overall use of wireless data will grow." (Broadbeam, 2000, p. 11) However, the PC market comparison doesn't fully apply for wireless technologies that are used mainly in the B-to-B environment where the critical customer mass and the sales volume development follow a different path from that of the B-to-C markets.

Investments in mobile solutions has as yet been fairly insignificant when compared to total IT investments. However, according to a study by Market-Visio, the share of mobile investments is growing and estimated to be around 15 % (in average) of all IT investments. Still, only 17 % of the companies estimated to invest more than 84 000 € (500 000 mk) in m-business. The m-business investments seem quite evenly distributed: outside services and in-house work both adding up to a bit less than 30 %, the share of software investments is 24 % and devices comprise only 20 % of investments. (Nikulainen, 2001, p. 24)

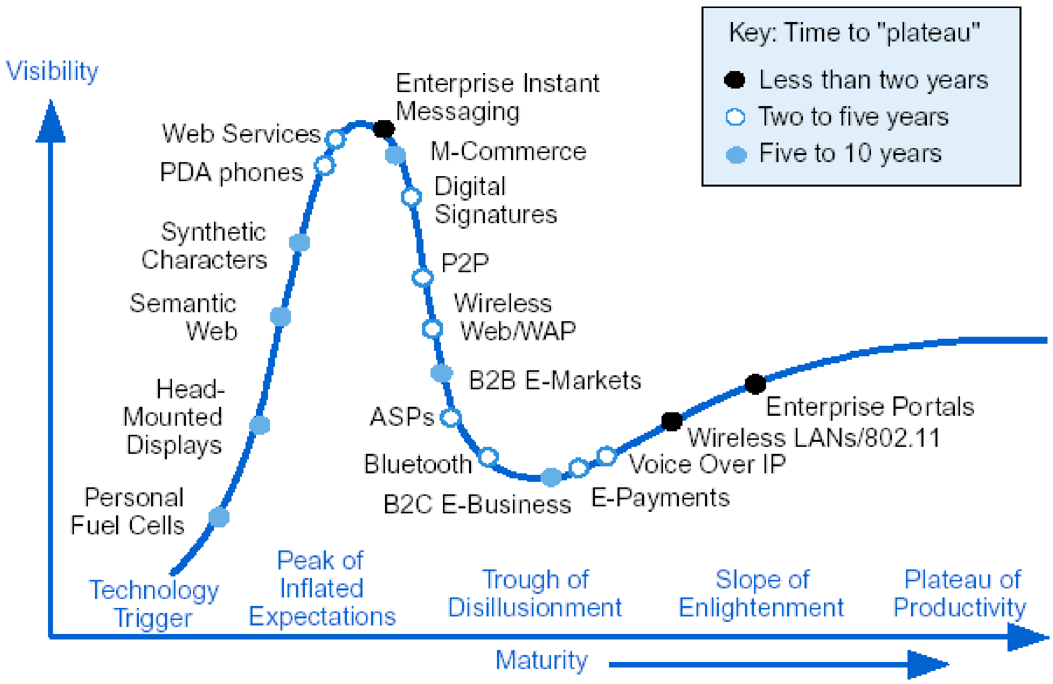


Figure 18. The Hype Cycle of emerging technologies and trends. (Gartner, 2001a, p. 19)

A study by the Gartner Group gives a general insight into the maturity of technologies and when they are estimated to reach the plateau of productivity. This is something that needs to be considered when deciding when to invest and on what technology. "Enterprises should select potentially high-impact technologies and adopt them early for maximum benefit, but should ride out the Hype Cycle for less-critical technologies." (Gartner, 2001a, pp. 19-20)

### 5.8.1 Timing the Investments

The price development of technology is a crucial factor when making decisions about the timing of the investments. "(Wireless) devices are still very much in the new product introduction phase that is characterized by slow growth and high prices. [..] there is an element of risk as the product's future is uncertain. As sales increase the manufacturing costs decrease, and as more units are sold the technology becomes established in the marketplace." (Parker and McQueen, 2001, p. 45)

The price is not the only issue in timing. “It is greatly dependent on the development of mobile networks and terminals. Therefore, the company should follow the development closely and define what are the appropriate entry requirements that have to be met before development takes place. Additionally, a migration path for the existing applications should be defined according to the new features of the mobile terminals and networks.” (Paavilainen, 2001, p. 138)

### 5.8.2 Investments In Real Life

Used arguments and the nature of the IT investments in general seem to be somewhat unscientific in the real business world. There is clearly room for progress in this area. What seems to be lucid is that certain conditions need to be met before any wireless investment initiatives are justified. Whether this is just the recession talking will be seen in the future. Devices and networks are required to be available and running before any investments are made in research or application development. Mobile operators claim that the major delays are caused by late arrival of handsets rather than the availability of the networks. Then again, device manufacturers see no reason for developing handsets if the infrastructure for using them is not available. The big players in Finland from the both sides are working together in developing the new technologies, but it seems that there is still room for more co-operation.

The price development of devices is not always seen as a relevant issue: prices stay the same, while the technology only gets better, i.e. more features with the same money. This is true in the long run when older technologies become obsolete. In shorter time span a certain application needs only certain features and, thus, new technology does not necessarily give any additional value. This is why the price development of the older technology becomes interesting.

# 6. M-Logistics

"Mobile SCM will not create a paradigm shift like the Internet, but will be an important enabler of the evolution towards streamlined and optimised business processes." (Müller-Veerse et al., 2001, p. 105) The effects of wireless applications on the logistics business function are evident and the utilization of wireless technology in different parts of the logistic chain is rapidly increasing. "The logistics and transportation business is becoming more time sensitive as manufacturing and retail require materials to be delivered on time. Additionally, at the same time, the management of multiple layered processes makes logistics and transportation increasingly complex. The field is also characterized by fierce competition and decreasing margins. Therefore, the maximum utilization of a fleet and other resources is needed in order to decrease costs and optimise customer satisfaction." (Paavilainen, 2001, p. 157)

This chapter aims to provide a framework for analysing the effects of wireless technology in logistics and will also describe the evolution of e-business and related issues in supply chain management. To be able to perform the analysis in an organized manner, two models are depicted. Logistics pyramid exemplifies the verticality of the logistics by naming different levels from strategic to implementational level. The supply chain approach helps to analyse the interorganizational nature of the logistics. The SCOR (Supply Chain Operations Reference) model is outlined and it is on the basis of this model that changes in the information flow are analyzed. The logistics costs trade-off analysis is performed in order to provide an insight into how investments in wireless applications can be justified. The chapter also looks at some auspicious areas for the application of wireless technology in logistics.

## 6.1 The Effects of Wireless Technology in Logistics

The effects of the use of wireless applications should be viewed at the different conceptual levels of logistics. These are the strategic, structural, functional, and implementational levels. The conceptual model of the logistics pyramid is presented in the Logistics Handbook (Robeson and Copacino, 1994, p. 261) and is used as an overall framework in the empirical section of the study.

Starting from the strategic level, the main objective is to improve the experience perceived by the customer, which eventually results in improved corporate profits. To reach this goal, the logistics productivity needs to be improved by reshaping the structural and functional levels of logistics organization by providing new solutions for the implementation. A comprehensive approach, that takes all the levels into account, will give the best results. The supply chain management approach is associated, in particular, with the structural level of the logistics pyramid and is further analyzed in the next subchapter.

At the functional level, modern warehouse design and operations and intelligent real-time transportation management are called for and the new technology will help to provide these solutions. Wireless technology has the potential to improve materials management. Lower levels of inventory and rationalized delivery procedures, but also more complex packaging and handling, might be the possible outcomes.

Wireless technology will have the greatest effect on logistics information systems by making available larger quantities of data of a higher quality. More automation and intelligence is added to several different processes such as ordering and delivery confirmation. M-logistics will require investments in new infrastructure. For example, systems hardware, communications and materials handling equipment may need to be updated or replaced altogether. Improvements in organizational management will be obvious since many m-workforce applications aim to improve the communications within the firm.

## 6.2 Supply Chain Management

The supply chain approach is a very archetypal way of illustrating and analysing the logistics function. The basic building blocks of a traditional supply chain and the information flows between them are portrayed in the figure below. The big arrows represent the material flow in the chain, which is often assumed to be simple and linear. “The reality is far from that. Supply chains are nonlinear, messy, error-laden, and full of complexity.” (Kalakota and Robinson, 2002, p. 202)

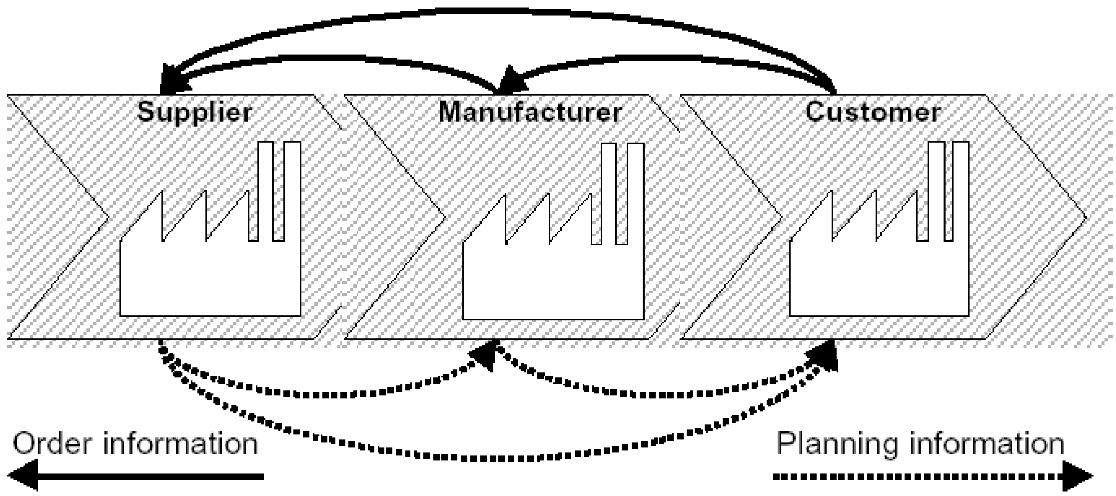


Figure 19. The traditional supply chain. (Hvolby et al., 2001, p. 4)

The extended supply chain is formed by linking the supplier-manufacturer-customer combinations into longer, often parallel and intertwining chains where each player adds value to the product or service that is delivered to the end-customer. This accentuates the importance of taking into consideration the whole chain from raw material supplier to the end-customer. “The objective of any supply chain design is to please the customer and to make money.” (Kalakota and Robinson, 2001, p. 292) The objective of supply chain management (SCM) is to make this come true in the most efficient way by an interenterprise integration of the supply chain, making the different players work together seamlessly. Basically, SCM deals with the coordination of material, information and financial flows. Conventionally, the SCM has been divided into planning and execution and these two functions have been employed on the implementational and functional levels of the logistics pyramid. SCM should, instead, be seen as a business strategy for creating new opportunities. SCM is not a technology issue. Since the focus has shifted from the internal to external process improvement, competition is seen as existing between the supply chains rather than individual companies. (Kalakota and Robinson, 2001, p. 271-275)

### 6.2.1 SCM and E-Business

“To really understand what mobility can do to improve the efficiency of supply chains and B2B commerce, it is important to look at the transformations taking place in the management of supply chains.” (Kalakota and Robinson, 2002, p. 201) The effects of e-business on supply chain management are discussed here in order to comprehend the evolutionary trends that are leading towards the extended mobility in the supply chain. In the rise of e-business, a great deal of new terminology emerged acceding to the supply chain concept. These definitions include electronic, responsive and intelligent supply chain, demand chain, and collaborative SCM. A new value proposition has been taking form: “Give customers what they want, when and how they want it, at the lowest cost.” (Kalakota and Robinson, 2001, p. 273)

**The electronic supply chain**; the impact of e-business on supply chain has been redefining channel structures. Disintermediation and re-intermediation are focal concepts that have affected, in particular, retailer involvement in several supply chains. The web has created new intermediaries such as e-marketplaces. In some supply chains there has been a clear transformation from the traditional chain structure towards a network or a community of loose relationships.

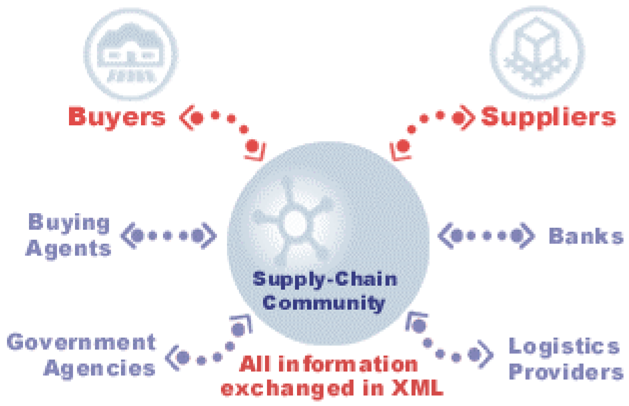


Figure 20. A supply chain community.

The Internet enables the formation of these communal places hosted by these new types of web middlemen or 4th parties where all the interest groups have equal access to information and related services. Such structures have, however, been criticized for creating situations where the comparisons of competing parties are based on limited or even incorrect information. This results in a distorted competitive setting, which ultimately stings the end-customer.

"**C-commerce** is fundamentally changing supply chain management, creating a new generation of applications that will enable and enhance business processes. However, these solutions are at the beginning of their life cycles." (Gartner, 2001b) Collaborative supply chain management contrasts with traditional SCM in several ways.

Table 4. Traditional and collaborative SCM. (Gartner, 2001b)

| | Traditional Four-Wall SCM | B2B C-Commerce Solutions |
|---|---|---|
| Focus? | | The Extended Supply Chain Network |
| Who? | The Enterprise and Specific Direct Trading Partners | The Community of Interest |
| What? | Optimization | Multiparty Collaboration |
| How? | Licensed Deployment | Subscription Model |
| Where? | Within an Enterprise and Its Partners | Among Partners |
| When? | Prescribed Times | Event-Driven |
| | Supply/Demand Matching | Network Response |

B2B c-commerce solutions are architected for the extended supply chain community and hosted by neutral third-party intermediaries. The Collaborative Planning, Forecasting and Replenishment (CPFR) Committee is a standardization body that has developed a set of business processes that entities in a supply chain can use for collaboration on a number of buyer/seller functions, towards overall efficiency in the supply chain. (CPFR, 2001)

In the **responsive supply chain** the information replaces inventory. This change is driven by the need to respond quickly to the requirements of ever more demanding customers, but also by the need for savings in inventory holding costs. According to Hughes (1998) the key features of a responsive supply chain are:

- Quick response
- Supply flexibility
- Customized manufacturing
- Synchronized scheduling with final demand

- Controlled supply processes
- Capability integration of trading partners
- Full use of electronic commerce
- Concurrent product development

Responsive and **efficient supply chain**s should be studied together as alternatives to each other. The firm needs to decide between these two structures depending on the nature of its products. Responsiveness is needed when the product life cycles are especially short. Examples of such products are personal computers and mobile phones. Paper is an example of a product that calls for efficient supply chain.

There is a movement towards a transparent **demand chain**. One key instrument in building responsiveness into the supply chain is the efficient consumer response (ECR). Basically, ECR is a mechanism that translates pull driven consumer demand into efficient supply by employing a number of already well known, if insufficiently practised, concepts and tools in supply chain management. Most importantly, the ECR requires an integrated approach in terms of automated store ordering via point of sale scanning, real-time sales data sharing on-line with all the parties, the joint development and integration of IT systems, close co-operation in planning and demand forecasting, the efficient scheduling and operation of product introductions, promotions and assortments, co-managed inventory and cross-docking. (Hughes et al., 1998, pp. 99-100)

### 6.2.2 Pervasive Supply Chain

At a theoretical level, what effects might wireless applications have on the supply chain structure? "Mobile applications are beginning to play a central role in enabling real-time supply chains." (Kalakota and Robinson, 2002, p. 205) The execution of the new value proposition is taken one step further with the wirelessness as the customer's needs can be answered truly ubiquitously. The responsiveness of the supply chain will intensify as the availability of information throughout the supply chain is more pervasive and timely.

The implementation of wireless applications is a step towards a so-called **Intelligent Supply Chain** (ISC) that is transparent and fully integrated. ISC concept was formed in the VIPRO project and comprises of four corner-stone concepts:

- A common way of operating,
- The ‘inventory = the whole supply chain‘ mindset,
- information integrity (congruence of material- and information flows) and
- anticipation based on advance information. (Riikilä, 2000)

**Visibility** in today’s supply chain is imperative. Especially the visibility of inventory in motion is taken into new heights with wireless solutions. (Kalakota and Robinson, 2002, pp. 216-221) This will enable the much desired proactive approach of management, which will result in better predictability. “Information visibility is enabled through use of an open communication architecture that integrates the multiple systems and applications necessary to provide information visibility across the supply chain.” (Sapiens, 2000, p. 3) RFID (Radio Frequency Identification) technology provides the necessary means for gathering unit-specific information automatically and on a real-time basis.

### 6.2.3 The SCOR model

ISC concept mentioned above calls for a common way of operating. The Supply Chain Operations Reference model can provide an answer to this, since it offers a standard way of describing supply chain processes. The SCOR is a process reference model that provides a common supply-chain framework, standard terminology, common metrics with associated benchmarks and best practices and that can be used as a common model for evaluating, positioning, and implementing supply chain application software. The model can be used to build inter-enterprise integrated supply chains. (SCC, 2001)

**The Supply-Chain Council**

The model has been developed and endorsed by the Supply-Chain Council (SCC) as the cross-industry standard for supply chain management. SCC is an independent not-for-profit corporation organized in 1996 and currently includes over 700 member companies (practitioners, technology providers, consultants, academicians, government) from a wide range of industries world-wide. (Stephens, 2001)

**SCOR Processes**

The model divides the processes into four main categories: plan, source, make and deliver. Processes associated with the return of product for any reason are included as a fifth main category in the version 5.0 of the model. Each of these process categories have three levels of process detail, the fourth level being the implementational level which is not included in the model scope. (SCC, 2000) The following diagram gives an overview of the SCOR model's hierarchy and structure.

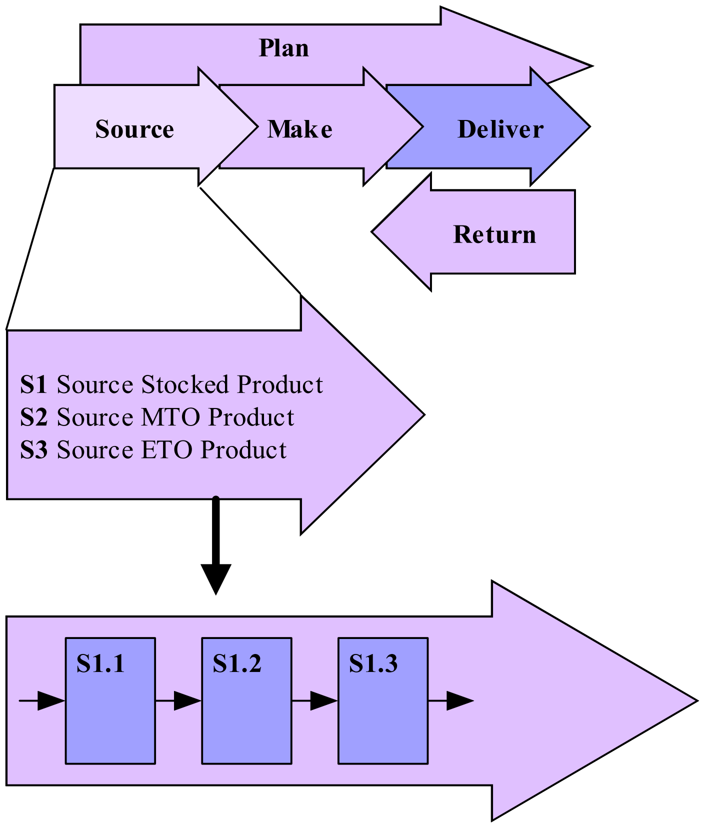


Figure 21. The SCOR model contains three levels of process detail. Adapted from (SCC, 2000, p. 3)

The top level lists the process types i.e. the main categories. Level 1 defines the scope and the content of the model. The configuration level lists the process categories. The process element level decomposes the processes into smaller units that are given definitions, inputs and outputs, performance metrics, and system capabilities. Level 3 is used for fine tuning operations. The ‘D1: Deliver Stocked Product’ -process is illustrated in appendix VII as a more detailed example of the process element level. Each of the level-three elements can be further decomposed onto the implementational level. The fourth level is usually very company specific and, thus, cannot be included in the standardized model.

## 6.3 Logistics Costs and Value Creation

The benefits that are reaped from the implementation of wireless applications come in the form of better customer service and cost savings. These often intangible benefits are difficult to measure and it is even more complicated to demonstrate to internal and external parties the real value that these benefits create. “Logistics costs are a major cost of doing business and logistics assets represent a significant portion of a firm’s total assets. Thus, reducing the total costs associated with logistics represents value creation for the company. However, the ultimate goal should not be to reduce one entity’s costs simply by shifting them to another firm. The goal should be to reduce total costs for the supply chain” (Lambert and Burduroglu, 2000, p. 2-7)

### 6.3.1 Measuring the Value of Logistics

Customers and the top management must be shown, on a regular basis, the value that is being created by logistics. The key metrics for measuring the logistics value are:

- customer satisfaction,
- customer value-added (CVA),
- total cost analysis,
- profitability analysis,
- strategic profit model and
- shareholder value.

“Customer satisfaction measures are the least quantitative in financial terms and shareholder value is the most comprehensive financial measure.” (Lambert and Burduroglu, 2000, p. 2) The last three necessitate increasing amount of numerical data in order to provide answers. From the metrics listed above the shareholder value is seen as being the most inclusive metric, although it does not fit well with the theoretical contemplation of the topic.

The first two methods aim at studying how customers experience the value of logistics. “Customer satisfaction measures by themselves are not adequate to sell the value of logistics internally. It is important to relate levels of customer service performance and the associated costs with revenue streams as well as costs.” (Lambert and Burduroglu, 2000, p. 3 ) Douglas M. Lambert presents a trade-off analysis in Logistics Handbook (Robeson and Copacino, 1994, pp. 260-302) that combines customer service levels and total logistics costs.

### 6.3.2 Logistics Costs Trade-Off Analysis

“Businesses can improve their market share by investing in logistics more efficiently and effectively than their competitors, thereby achieving higher levels of customer service in a cost-effective way.” (Lambert and Burduroglu, 2000, p. 3)

The logistics costs trade-off model (see the following figure) shows how the total logistics costs are comprised of different cost elements. These elements are: customer service levels (the cost of lost sales), transportation costs, warehousing costs, order processing and information costs, production lot quantity costs and inventory carrying costs.

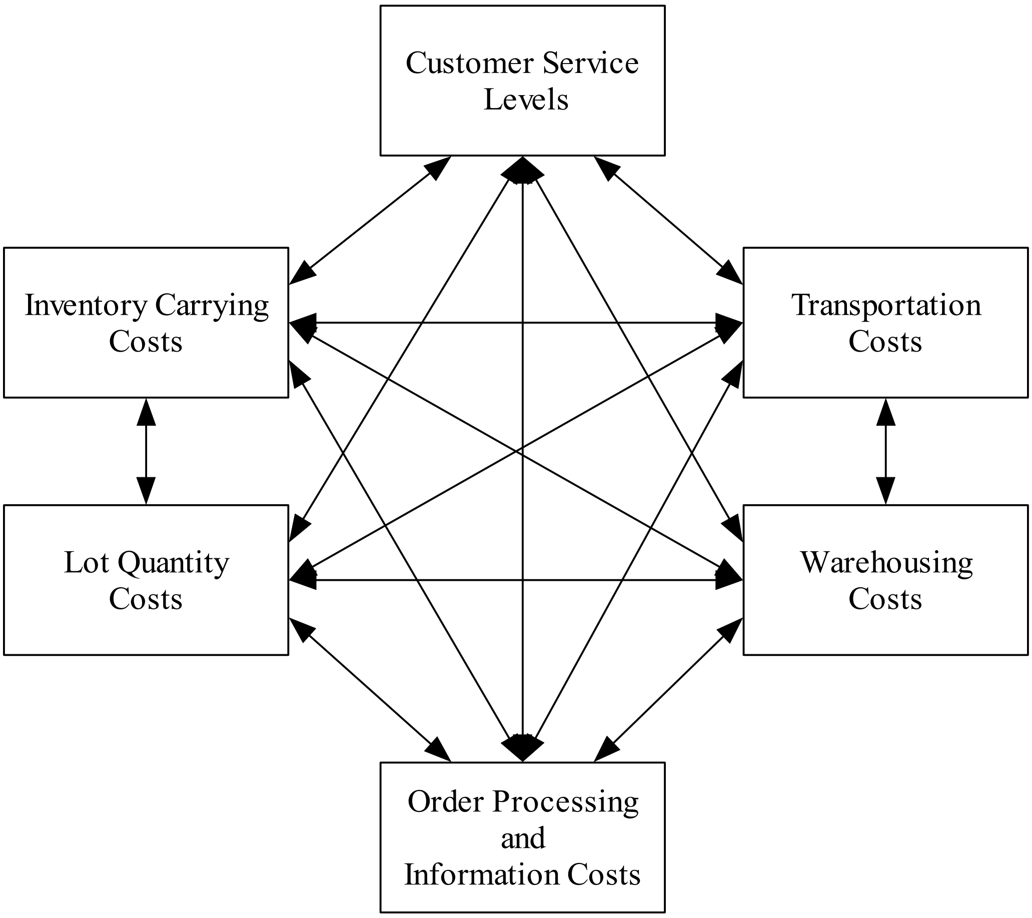


Figure 22. Logistics cost trade-offs. Adapted from (Robeson and Copacino, 1994, p. 270)

“Reductions in the cost of one logistics activity invariably lead to increased costs of other cost components. Effective management and real cost savings can be accomplished only by viewing logistics as an integrated system and minimizing its total cost.” (Robeson and Copacino, 1994, p. 269) This analysis attempts to point out how an investment in wireless logistics application can reduce costs in certain categories without leading to major trade-off effects on the other components.

In the model, the customer service levels represent (in addition to cost of lost sales) also the logistics interface with demand creation, the place component of the marketing mix. “Customer satisfaction occurs when businesses successfully fulfill their obligations on all components of the marketing mix: product, price, promotion and place. The place component represents the manufacturer’s expenditure for customer service, which can be thought of as the output of logistics system.”

(Lambert and Lewis, 1983, p. 50) A customer centric approach aims to minimize the total of the other logistics costs, given a desired level of customer service. The logistic system presumably becomes more efficient due to the utilization of wireless applications.

## 6.4 The Utilization of Wireless Technology in Logistics

There exists an abundance of possibilities for exploiting system mobility and wireless applications in logistics. Evans (2002) in his book 'Business Agility: strategies for gaining competitive advantage through mobile business solutions' provides the following list of opportunities for wireless enablement in supply chain management:

Table 5. Wireless applications in supply chain management. (Evans, 2002, pp. 66-67)

| **Wireless SCM Opportunities** | |
|---|---|
| Incident reports | Instructions and sales orders |
| Just-in-time inventory management | Pick orders |
| Delivery and receipt confirmations | Logistics tracking |
| Reports and printouts | Quality control and inspections |
| Vendor performance monitoring | Inventory management |
| Warehouse management | Asset management |
| *Mobile inventory tracking* | *Alerts and event notification* |

From the preceding list here are presented two very prominent application areas that will most likely reshape and integrate the supply chain. The example application introduced in the empirical section of the study includes elements of the both alert generation and location-based services.

### 6.4.1 Alert Generation Applications

"Information collected from primary data sources has to be communicated to decision-makers and fed into respective enterprise systems. Alert generation applications can deliver timely and actionable alerts to corporate mobile employees.

The key properties of such systems should include: connectivity to enterprise systems, ability to create flexible business rules that trigger messaging events, ability to deliver information intelligently through a variety of channels, interactivity features that allow the user to react to specific alerts in a predefined way.” (Müller-Veerse et al., 2001, p. 109) Alert generation can render employees less dependent on physical spaces when remote interaction is possible. Automatic alerts have also an important role in making the supply chain proactive.

### 6.4.2 Location-Based Services in Transportation

”Location-based services have a great potential for the transportation industry. They also enhance the security of the drivers because there is always someone who knows the location of the truck. [..] Another strong point for location-based solution is increased efficiency because of better route planning and the ability to forecast arrival times. Some of the common functions of location-based transportation solutions are: vehicle utilization measurement, driver performance measurement, location-based dispatching, dynamic route planning, integration with the Internet tracking system, profit and loss reporting, graphical maps for a dispatcher showing location of the drivers, driver hours tracking.” (Paavilainen, 2001, pp. 158-159)

# 7. Developing Wireless Applications for Paper Industry Logistics

This chapter introduces the empirical section of the study and explains how the process of evaluating and developing wireless applications progressed and what kind of obstacles were encountered on the way. At first, an example application in paper industry delivery logistics is presented in the form of a case study. This chapter also discusses the role of technology research as the groundwork for this study. In addition, one key technology, RFID is introduced. The process model of evaluating and developing applications is explained step by step.

## 7.1 Example Application: Delivery Tracking

One of the most prominent ideas that was evaluated and developed in the process was a tracking of reels and pallets that are in delivery from the mill to the printing press.

### 7.1.1 Classifying the Delivery Tracking Application

The theory presented three frameworks for classifying a wireless e-business application. According to these classifications the delivery tracking application can be defined as a being a vertical mobile supply chain management application with extended mobility dimensions that also offer tracking and other information services to horizontally varying groups.

First of all, this means that the application’s main focus is to enhance the performance of one vertical plane, that of supply chain management. The extensive mobility dimensions increase the potential number of users and make the overall information more timely. Application design must, however, also take into account that less features can and should be offerred simply since there is diverge scale of access possibilities in extended mobility environment. The horizontal dimension is important for ensuring that the appropriate information is available wherever it is needed. This sets its own conditions for application design.

### 7.1.2 Expected Changes and Improvements

The targets of the application concept were to:

- increase the timeliness of the information,
- automate the identification throughout the logistic chain,
- include more unit-specific information (quality, etc.) in the delivery,
- simplify the re-routing of units,
- allow proactivity and tracing in mishandling cases, and
- enable more timely alerts for different parties.

According to lead users' preliminary assessment these changes would enhance the logistics process by:

- bringing more proactivity into the supply chain,
- fulfilling the requirement of the Intelligent Supply Chain concept for transparent, real-time inventory,
- increasing the responsiveness of the supply chain,
- resulting in less waste and lost units,
- reducing the overall logistics costs, and
- improving the customer service.

### 7.1.3 Concerns For Feasibility

The idea also brought forward concerns that need to be answered before its feasibility could be justified:

- availability of technology,
- standardization,
- technology costs,
- the scope of implementation, and
- the involvement of the whole cluster.

The concern of getting all the relevant parties of the cluster involved in the process of making the system happen is legitimate. The implementation of RFID delivery tracking application can only succeed and generate benefits if the Finnish paper industry as a whole, related logistics providers and major port operators in the EU as well as the biggest customers, are committed to the program. (Salonen, 2001), (Korhonen, 2001)

### 7.1.4 Delivery Tracking In Detail

A detailed, step-by-step description of the application was envisioned:

1. A paper reel or a pallet is ready for shipping in the paper mill. A tracking device is installed and the information on the product is added (what kind of paper, size/amount, quality, destination, delivery date etc.) directly from the manufacturing and order information systems. Relevant information can also be sent to customer every time the tracking device comes into contact with another unit (a truck, warehouse, fork-lift, customs, etc.).
2. The product is loaded onto a transportation unit (a truck, train, ship, plane) which reads the delivery information of all the cargo (this can be a mix, different products and destinations) and accordingly automatically creates an optimized route and gives an estimates the delivery time. The step is repeated along the route if the transportation mode changes and each time the delivery estimate is readjusted. In the case of a possible late arrival, an alert will be sent to the relevant parties.
3. If required while in transit, the transportation unit takes care of the positioning and sends the status information to essential parties on a real-time.
4. When stored at some point during the delivery process, the product communicates with the warehouse system which, for its part, passes the information to other systems.
5. If necessary, the product can be re-routed at any time by changing the delivery information on the device.
6. When the product arrives at its destination, the customer's system automatically signs in the delivery and adds the unit to the inventory. It reads the quality data to adjust the print accordingly.

Appendix III presents a graphical model of the application. The model corresponds with the above description and includes material and information flows and some of the various parties involved, from the paper mill to the printing press.

## 7.2 Charting The Technology Landscape

The groundwork that started off this study was carried out as a sub-project of a three-person group specialized in wireless terminal and network technologies and enabling services such as security, billing and middleware provision. The technology group charted the availability of the wireless technologies now and in the near future. The information was structured under main categories that are represented in the appendix I in the form of a mind map. All the gathered wireless device data was also organized in a database where it can be easily managed: updating is effortless, information search even more so. An extensive technology overview and a database management analysis was constructed in the project and as a result another thesis parallel to this one was completed. The third thesis, which was written in the wireless technology sub-project, concentrated on enabling services.

## 7.3 RFID Technology

The most imperative wireless technology for the case application studied in this thesis is radio frequency identification (RFID) technology which is described here.

### 7.3.1 Technology

RFID is a wireless technology that provides efficient means of automatically identifying, tracking and tracing different mobile units. The main components of the technology are a transponder and transceiver. The transponder is commonly called a tag or label (with integrated circuit (IC) and antenna), which is electronically programmed with unique information and attached to any mobile unit. A transceiver device is used for transferring data to and from the unit.

RFID technology still lacks a proper standardization and several different frequency ranges are in use from which the most common frequencies are:

- Inductive systems
  - LF 125 kHz
  - HF 13.56 MHz
- Radiating systems
  - UHF 869 MHz
  - µW 2.45 GHz

RFID tags are categorized as either active or passive. Active tags are powered by an internal battery and hence are bigger and more expensive. From the perspective of the case application, the more interesting passive tags operate without a separate power source and obtain externally generated operating power from the reader. “Passive tags are consequently much lighter than active tags, less expensive, and offer a virtually unlimited operational lifetime. The trade off is that they have shorter read ranges than active tags and require a higher-powered reader.” (AIM-Global, 2001b) Since the passive tags are batteryless they are environmentally healthier.

“Many different reader/writer types can be found depending on the application requirements. There are portable devices (like hand held devices) and stationary devices (like printers, terminals, but also typical configurations with a longer operating distance like gates, tunnel readers and many other arrangements).” (AIM-Global, 2000, p. 6) Driven by the requirements of smart label markets, many vendors already offer combined barcode- and RFID readers to allow operation of different technologies. Readers with different integrated wireless network technology options, such as GPRS, are also emerging.

### 7.3.2 Key Advantages

“The significant advantage of all types of RFID systems is the noncontact, non-line-of-sight nature of the technology. Tags can be read through a variety of substances such as snow, fog, ice, paint, crusted grime, and other visually and environmentally challenging conditions, where barcodes or other optically read technologies would be useless.” (AIM-Global, 2001b) RFID technology allows reading in challenging circumstances at remarkable speeds, in most cases responding in less than 100 milliseconds. However, typically longer operating distances result in lower operating speed.

“The read/write capability of an active RFID system is also a significant advantage in interactive applications such as work-in-process or maintenance tracking. Though it is a costlier technology (compared with barcode), RFID has become indispensable for a wide range of automated data collection and identi-fication applications that would not be possible otherwise." (AIM-Global, 2001b)

Another advantage is the possibility to choose between disposable and recyclable RFID tags. Durability and re-usability are important features of recyclable tags. "It is commonly agreed that for applications where the same item can be used several times, for example for identifying pallets or returnable containers, an RFID label could be have a lifetime of 10 years." (EAN.UCC, 1999, p. 11) Another feature is the ability to handle multiple tag readings at the same time. A reader uses an anti-collision algorithm to read numerous tags that are in the field of the reader at the same time. Since the RFID data can be encrypted and labels password protected, the technology can be considered secure. In conclusion, RFID is not seen as replacing other data capture technologies already in use, but as an additional tool for assisting in the management of the supply chain.

### 7.3.3 Constraints

The most significant limitation that the paper industry is facing in the RFID implementation is the reading range that is a combination of numerous factors. The frequency, transmit power, antenna sizes, noise robustness, and the signal absorption of different substances all are examples of these factors. Metallic or other conductive materials environments can remarkably hinder the data transfer. This greatly interests the paper industry in the area of coated paper deliveries.

"If there are some liquids between the reader and tags the reading could become difficult or impossible in some cases. Tags characteristics may be altered by the liquid and reduce reading range or eliminate ability to be read." (EAN.UCC, 1999, p. 14) Technology can also be susceptible to electromagnetic interference (EMI) from computer equipment or other technologie, such as WLAN or Bluetooth if the same frequency band is used.

The prices of tags are still quite high, but will eventually come down significantly, once a certain technological platform and a critical mass has been reached. Other limitations include rather low data storage capability and data transfer rates, the difficulty in focusing signals as well as a lack of standards. One must bear in mind, however, that standardization issues can be seen both as advantages as well as limitations. Also the behaviour of electromagnetic waves (reflection, refraction and diffraction) used in the radiating systems (UHF, μW) can have both positive and negative effects on the usage. The table below summarizes all the advantages and the constraints.

Table 6. Advantages and constraints of RFID technology.

| Advantages | Constraints |
|---|---|
| + Noncontact, non line of sight | – Reading range |
| o Robustness | o Conductive materials |
| + Read/Write ability | o Susceptibility to EMI |
| + Recyclability | – Cost |
| + Multiple simultaneous readings | – Data storage capacity |
| + Very quick readings possible | – Data transfer rates |
| + Security | – Signal focus |
| | – Lack of standards |

### 7.3.4 The Use of RFID In Logistics

The use of RFID tag in the supply chain management helps in the tracking and tracing of different units on a real-time basis. RFID also offers a solution to the problem of multiple labeling by various parties. One label for each reel, pallet or other unit would in most cases be enough. The information on the tag could include the Serial Shipping Container Code (SSCC) and the Global Trade Item Number (GTIN) of the product. The batch number, the best before date, Net weight in the case of variable weight, the consignment number and “Ship to, Deliver to” postal code could also be included. All these information items are based on the standard EAN.UCC form.

Tags used in logistics can have sensors attached to them. The paper industry is interested in this because in problem situations (forklifts dropping the reels etc.) it is essential to be able to trace when and where the problem has occurred. “For example a temperature sensor can be attached and a tag programmed to poll the sensor at regular intervals. In this way a temperature/time profile can be recorded on tags attached to goods that need to be distributed under cool or chilled conditions. Similarly devices to sense shock can be attached, so that tags can record the times at which items are dropped or struck. This data helps to pinpoint defective goods before they are put to use or sold to a consumer and provides information on where damage has occurred so that appropriate action can be taken.” (EAN.UCC, 1999, p. 19)

The following example illustrates a logistics application where RFID technology is used for inventory control.

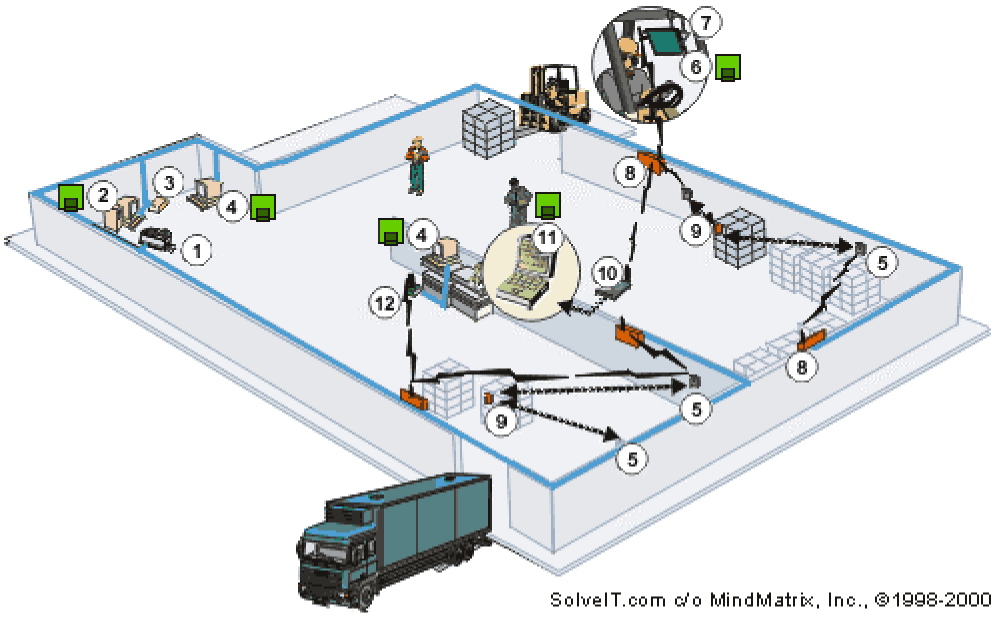


Figure 23. An inventory control application using RFID technology. (AIM-Global, 2001a)

Some of the components listed in the figure include: 5) An RF Reader for aquiring data, 6) A vehicle-mounted computer in a forklift, 9) An RFID tag attached to a unit, 10) An RF Interface adapter for PC, and 11) A laptop PC for accessing data.

### 7.3.5 Current RFID Research

The RFID technology is very promising and is studied extensively in many diverse clusters. The Finnish paper industry including Stora Enso, UPM-Kymmene and M-Real in co-operation with logistics providers, several equipment manufacturers and other interest groups are working on an Intelligent Paper Delivery (IPD) program, where one central concern has been the RFID –project. (Salonen, 2001) RFID and wireless technologies in logistics also play a central role in ELO project of the National Technology Agency (Tekes). (Kaitasalo, 2002), (Kekäläinen, 2002) VALO –program by Finland's Ministry of Transport and Communications includes a RFID –project that concentrates on developing tracking of the procurement process of textile industry. (Siitonen, 2002)

Technical Research Centre of Finland (VTT) is involved in an EC project that is concentrating the research on the frequency ranges of radiating systems. The so-called PALOMAR (Passive long distance multiple access high radio frequency identification system) project consortium aims to develop the necessary technology for a cost effective long range passive RFID solution. (VTT, 2001) The solution is addressing mainly the challenges and requirements of the paper industry supply chain integration. The ultra high frequency (UHF) band has been especially promising because of the focused reading capabilities and an adequate range of about four meters. (Varpula, 2001)

GTAG (Global Tag) is an initiative by EAN International and UCC (Uniform Code Council) which aims at developing common RFID performance standards. "It is generally agreed that Radio Frequency Identification technologies present opportunities for supply chain management applications. A barrier, which currently exists, is the lack of open standards regarding the use of RFID. As a leading worldwide organization providing data and Automatic Data Capture standards, EAN International and the UCC take a pro-active role in this field." (EAN.UCC, 1999, p. 5)

AIM (Automatic Identification Manufacturers) have their own RFID Council and technical committee that has organized projects on the topic. Current projects concentrate, for example, on developing specifications for the RFID conformance and for the smart label printers. (AIM-Global, 2000) Also MIT has their own extensive RFID program that includes such co-operating companies as Wal-Mart, International Paper, Procter & Gamble, and Unilever. (Semilof, 2001)

### 7.4 The Evaluation Process of the Application Ideas

The evaluation of the ideas was executed in multiple stages. The first ratings were given by the lead-users at the brainstorming session where about fifty ideas were originally produced. The evaluation process begins where the process of generating ideas finishes. The following figure depicts a model for evaluating and developing application ideas.

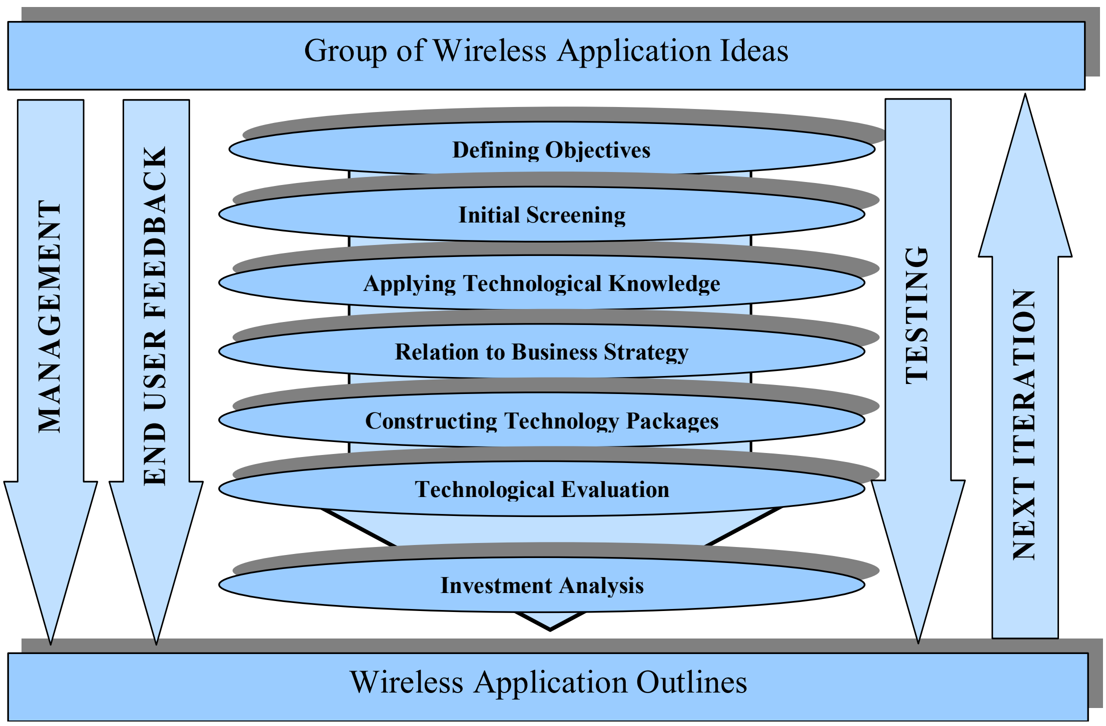


Figure 24. Process model for the evaluation and development of wireless applications. (Sissonen et al., 2002, p. 6)

The process can be seen as a development funnel: "That is, a gradual process of reducing uncertainty through a series of problem-solving stages, moving through the phases of scanning and selecting and into implementation –linking market and technology –related streams in the process." Managing the innovation process is an act of balancing between the costs of continuing with the projects and the danger of eliminating potential fruitful options. (Wheelwright and Clark, 1992), (Tidd et al., 1997, p. 250)

The process consists of two different kinds of steps that are alternating. The first type aims at gathering information and applying it into the process to develop the ideas further and thus support the decision making. Secondly, there are steps that use the information to evaluate and screen the ideas. This approach anticipates to compromise the risks of screening out sound ideas and the directing of the resources promptly into right targets.

### 7.4.1 Defining Objectives

The first step of the process provides the system with information about an exemplary wireless application. It sets a goal for the process by describing the attributes that define a good application. The chapter five defined the attributes of an ideal wireless application. Such an application should for example have compelling advantages in terms of the wireless e-business value drivers i.e. the wireless quotient. The wireless quotient consists of ubiquity, intimacy, time-sensitivity and location awareness.

### 7.4.2 Initial Screening

To be able to focus the limited resources on the best ideas an initial screening was conducted by a multidisciplinary decision-making group, which was comprised of members from the technology and innovation team, present situation experts, and the project leader. The screening checklist consisted of the following screening steps:

1. Business concept ideas, which were investigated separately in the project using dissimilar methods.
2. Technologically infeasible ideas.
3. General ideas, which couldn't be developed into actual wireless applications.
4. Ideas that would also need a strong development effort from external parties that the company could have no influence over.
5. Conjoining congruent ideas.

At this point the ratings from lead-users were employed to select the best ten from the remaining ideas.

### 7.4.3 Refining the Ideas In the Light of Technological Knowledge

The original wireless application ideas fresh from the GDSS session were somewhat general and unripe descriptions consisting of few sentences at best. The rudimentary idea of the need for mobility that the lead-users had recognized in their industry was combined with the project's technological knowledge to develop the ideas to the next level. The core idea of the application was refined, more features around it were designed and an exemplary case was envisioned. The success of the step depends largely on the ground research of wireless technology, target industry and its present technology and standards, and wireless applications in general.

The technological key issue of delivery tracking idea was to find all the different options for unit tracker technology. The decision making process is described in a following sub-chapter 7.4.5.

### 7.4.4 Relation to Business Strategy

The applications to be implemented need to be in line with firm's strategy. A survey among the managers of a firm was carried out to obtain the necessary information. (Laaksonen, 2001) The prominence of the delivery tracking example was seen very high by all the participants. The strategic views from the survey are summarized in the following figure.

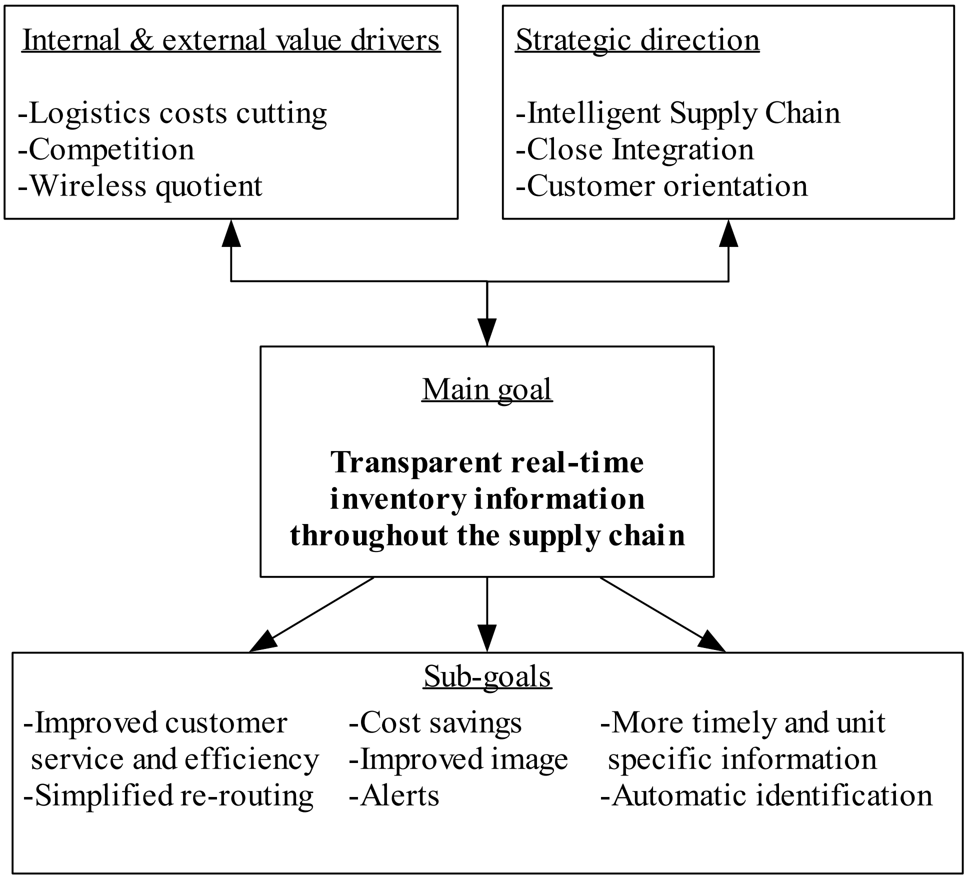


Figure 25. Delivery tracking application in relation to business strategy. Adapted from (Paavilainen, 2001, p. 137)

The ideas that did not rouse the managers' interest can be re-analyzed and refined or possibly even discarded.

### 7.4.5 The Construction of Technology Combinations

When combining technology packages the most logical decisions could be made intuitively in the light of the facts and the experience that the technology group had collected. A database that enables data mining is used to assure organized up-to-date information. To help with more complex selections simplified decision trees were constructed. Here is portrayed an example of a decision tree that was used in deciding what kind of unit tracker would be the best in the case application.

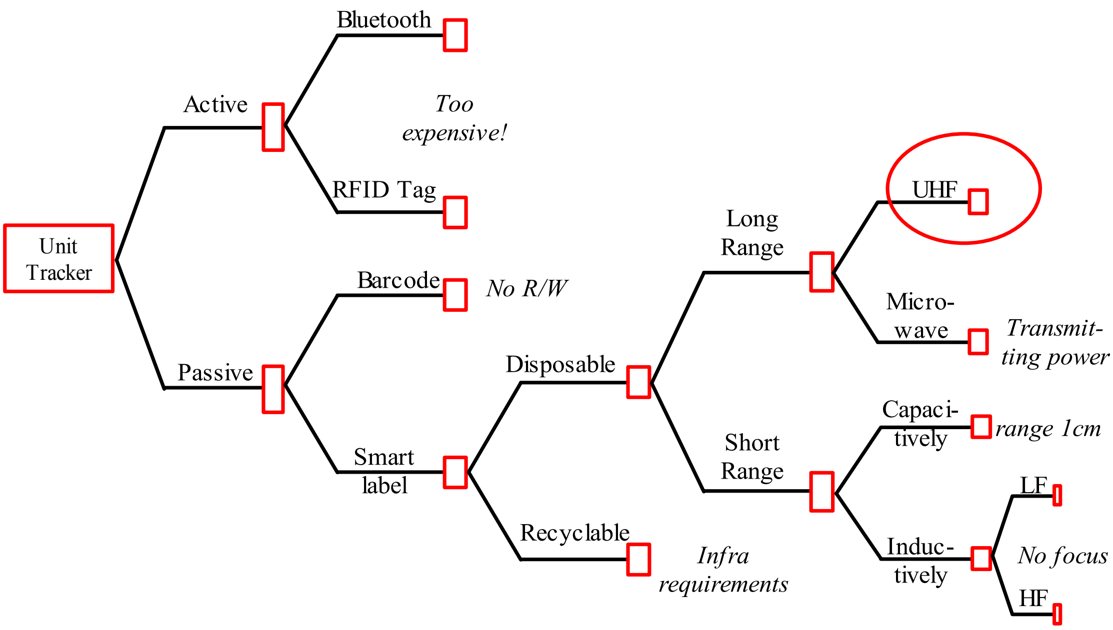


Figure 26. Decision tree, choosing a unit tracker.

The decision tree consists of two main branches, from which the active (i.e. one that has its own power source) could be eliminated because of the expensiveness of the technology. From the passive technologies, barcode is already widely in use and doesn't have the possibility to re-write the information in it. Answer to this problem is the RFID smart labels. According to research done in the VIPRO-project the organization of the recycling would be too arduous, thus the disposable labels were chosen. (Korhonen, 2001) From the several different frequency possibilities only Ultra High Frequency (UHF) seems to offer both focused reading capabilities and adequate range when considering the current transmit power limitations. The decision tree's capability of contemplating the future scenarios was not considered in this study.

### 7.4.6 Evaluating the Technological Attributes

The next phase was to evaluate the technological attributes of the chosen ideas. A theoretical analytic hierarchy process -model was built for this purpose. The model wasn't used in the first phase of the project and thus no empirical data related to AHP usage is introduced in this thesis. However, the model that is portrayed in appendix IV gives an excellent overview of the things that need to be considered when comparing the application ideas. The model was used in this purpose, as a clarifying framework. The first level of the hierarchy is composed of the main criteria, which all have three to five subcriteria. The criteria are explained here.

**Technology Risks**

Technology risks include the possibility of delay in the introduction of a new technology; security breaches; technology becoming obsolescent; standardization uncertainties; and the breadth of geographical coverage or availability of technology. Delivery tracking application's technology risks reside in unclear standardization and regulation issues, protracted introduction of UHF range technologies, and for LF-HF range technologies the risk of obsolescence. The following are other examples of technology risks of different wireless networks.

UMTS (Universal Mobile Telecommunications System) network technology is a good example of delayed technology. Security is clearly a problem in the WLAN (Wireless Local Area Network) technology and the obsolescence of Mobitex network is obvious. Both Bluetooth and WLAN are designed to work in the same open frequency band, which results in interference between the two and thus there is a problem that dawns from the lack of standardization. GPRS (General Packet Radio Service) is an example of a geographically problematic technology since it is not widely available at the moment.

**Design Dynamics**

As explained in the chapter about wireless application development the flexible design of the application is important. The attributes to consider include scalability, adaptability and backward compatibility. For the example application there are some things to be considered that would enable a dynamic design. The ability to function even if bigger reel sizes are introduced. Mobile interface that would be adaptable according to the needs of different mobile devices of customers. The tracking application would most likely start as a pilot to assure the functionality. Scalability is then asked for once the pilot is launched in full breadth.

**Technology Compatibility**

Three subcriteria were identified that define the application's technological compatibility. First, application might be able to exploit technology that is already in use in the company. The company might have experience and expertise that could help in the implementation phase and the actual usage of the technology. Second, some of the technologies used in the application might or might not be interoperable with company's current selection. Third, it is beneficial if the application is compatible with other new projects under consideration. Hence the project portfolio would be easier to manage and the investment costs could be shared between the projects.

Delivery tracking can benefit from using the already installed GPD technology of the transportation units. RFID technology has similarities to bar codes, and thus the workforce would adopt it easily. The application would use WLAN networks in warehouses and other facilities. This is already quite well known and vastly implemented technology and hence a good choice.

**The Wireless Quotient**

It is good to evaluate the applications in the light of wireless e-business value drivers presented earlier. The higher the wireless quotient, the better the chances to succeed. The value drivers include ubiquity, intimacy, time-sensitivity and location awareness.

The delivery tracking idea fulfills on some level all the value driver dimensions. Only the ubiquity is a bit more limited by the availability of RFID readers. The information can be transferred only when transponder of the label comes in contact with a reader. The intimacy surfaces in two different ways: Each reel or pallet has its personal device and the information can be profiled personally to each user of the system. As we speak about the timeliness and visibility of supply chain the time and location sensitivity of the application are evident.

### 7.4.7 Investment Analysis

To be able to convince the management that certain wireless technology investments are justifiable, costs and benefits need to be assessed. There are clear problems in analysing the IT investments since the benefits are by and large intangible. Numerical data is difficult to obtain. The benefit side was charted implementing a survey among the top-level managers of the industry. (Laaksonen, 2001) The conventional tools such as net present value calculations don't necessarily give satisfactory answers to these problems and therefore new ones should be applied. Real options method is a tool that gives better possibilities to measure and classify also those benefits that wouldn't traditionally be included in the analysis. This part of the application evaluation was conducted in another thesis of the project and won't be discussed here.

### 7.4.8 Ongoing Tasks of the Process

Application testing, piloting in small scale, and end user feedback are important sources of information (Andersson, 2001). All these should be performed throughout the process. The testing in the project was limited to a general usability tests of technology. Due to resource limitations only some wireless devices such as communicator, handheld, and palmtop devices were tested in WLAN network. Nevertheless, the tests gave a good indication what level hands-on experience is required to obtain realistic view of the technology. More extensive testing was planned for the future. An intensive relationship with the end user is very resource demanding. Information was gathered from the lead users and through some interviews. Also a survey for the end-users was planned. Because of the limited resources and the theoretical nature of the study the both testing and end user feedback were less processed at this time.

The model includes a link back to the beginning to emphasize the iterative nature of the process. Ideas that were already discarded once can be taken back into the process in the light of new information. Equally iterativeness should be understood on higher level: innovation is a continuous process.

## 7.5 The Implications of Delivery Tracking Application in Logistics

The framework that was developed in the chapter on m-logistics is used here to analyze how, in particular, the delivery tracking application might affect the different conceptual levels of logistics, how it helps to realize the paper industry's ISC concept and what cost savings it can impose.

### 7.5.1 The Effects On Different Conceptual Levels

The effects of delivery tracking wireless application can be seen on all levels of logistics pyramid (see the following figure). The implementation of a new RFID technology throughout the supply chain and the introduction of new procedures and additions to the information systems can bring about significant changes to the functional level of a company's logistics. This will help in transforming the supply chain into one big transparent and dynamic inventory. Automatic identification and easier re-routing will make the transportation management proactive. The structure of the supply chain will, thus, becomes more responsive or even proactive, which will again fulfil the strategic goal of improved customer service. In addition to more gratified customers, the second major objective of supply chain management will also be achieved: overall logistics costs will be cut. The cost analysis is presented in chapter 7.5.5.

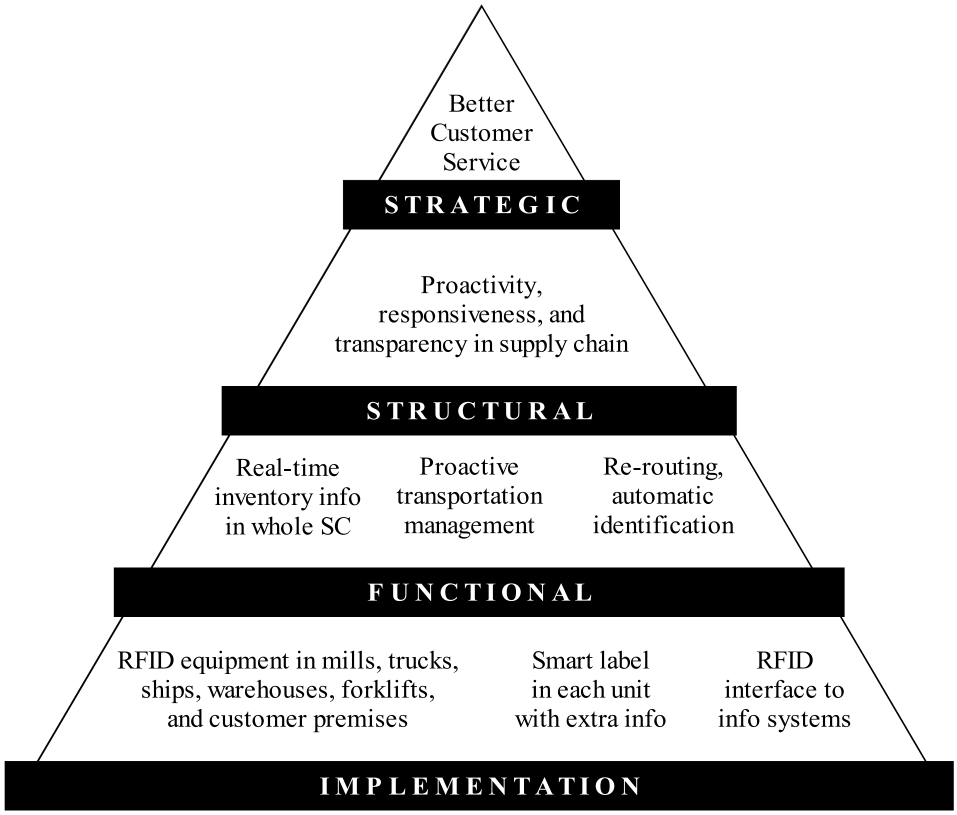


Figure 27. The effects of the delivery tracking application at different conceptual levels.

### 7.5.2 SCOR Model Analysis

The SCOR model is used here to analyse the delivery tracking as a process. The third detail level of SCOR model on the delivery of the stocked product includes 13 phases. This process diagram, presented in appendix VII, is used as a reference model for the delivery process which is then applied for benchmarking of an actual paper industry delivery process. By analyzing the delivery tracking application in the light of the model, it was concluded that several phases might be improved. The benchmarking demonstrated that in the current delivery process of paper industry there is an obvious demand for RFID based delivery tracking application.

### 7.5.3 The Bottlenecks of Today's Paper Delivery Process

Although the paper industry supply chain is often said to be very fine tuned, there is still an abundance of possibilities for improvement. A typical structure of a delivery chain of a Finnish paper manufacturer, presented in the figure below, consists of three legs which are the domestic and international land forwarding legs and the shipping leg in between from the port of loading (POL) to port of destination (POD). Very often, forwarding in the country of destination is divided in two parts. The delivery first arrives at a warehouse or a distribution center (usually at the port of destination) from where it is forwarded according to customer call-offs.


Figure 28. The typical delivery chain of a Finnish paper manufacturer. (Aaltonen, 2002)

The practice is customer oriented as the deliveries arrive precisely and responsively. However as a consequence, the paper manufacturer is caught in an inefficient situation where considerable capital investments are tied up in highly refined products that sit in warehouses around the supply chain. This is a classic example of sub-optimization. Actual real-time end-customer data is not available, which leads to inaccurate demand forecasts due to Forrester  effect that moves up the chain.

The deliveries in the case company are planned in three phases. A centralized transport management system takes care of the planning. The process starts with an allocation of shipping capacity for the 2$^{nd}$ leg of the delivery chain. Once the shipping leg is assured the second phase can book rail transportation for the domestic forwarding. The third phase is responsible of booking the transportation for the international forwarding to the destination. Usually, the scheduled orders exceed the capacity of transportation unit. . It is for this reason that load optimization has taken an important role. The paper mill books the necessary rail cars or, in some cases, trucks for each order. It is not always certain that a unit with preferred capacity is available and, thus, ad hoc load optimization may be needed.

About 80% of the manufacturing is based on actual customer orders and only 20% are made to stock (MTS). Additionally, MTS manufacturing is mostly customer-specific and only a small portion is common bulk manufacturing. For example, each printing press have their own specific reel width. Also, each customer attempts to optimize the width in order to minize the amount of paper that goes to waste. (Aaltonen, 2002) Hence, the reel width is implausibly arbitrary, and therefore different orders are rarely interchangeable.

As the order moves down the delivery chain it must be checked and confirmed at each handling point. Currently in most points only a quantity tallying is performed. The correctness of each reel is assured only at the port of destination. The process of checking the units manually is quite laborious not to mention time-consuming.

### 7.5.4 Phase-By-Phase Process Analysis

The phase D1.10, 'Load Vehicle, Generate Shipping Documents, Verify Credit & Ship Product' that has to do with the actual transportation phase of the delivery process is particularly affected by the application. The possible modifications of the process elements are listed below.

In the phase **D1.3** (**Reserve Inventory & Determine Delivery Date**), when the inventory is reserved for specific order, information can be updated immediately: the destination and delivery date are saved in label once the order is manufactured. This function executes the SCOR model's desired best practice for the element: "Automatic reservation system of inventory and dynamic sourcing of product for single shipment to customer." (SCC, 2000, p. 131)

If the processes of picking and loading the product (**D1.9** and **D1.10**) are designed to be more dynamic and ad hoc by nature, there is a chance that the process elements **D1.4 Consolidate Orders**, **D1.5 Plan & Build Loads**, **D1.6 Route Shipments**, and **D1.7 Select Carriers & Rate Shipments** would be carried out just-in-time, upon the arrival of the carrier at the dock. This would increase the responsiveness in the process which is required, for example, if loading capacities vary greatly between the carriers. This happens to be true for paper transportation where the carrier can be anything between a smallish 20-ton truck and a 64-ton rail car. (Aaltonen, 2002)

**D1.6 Route Shipments**: The re-routing process will be made more responsive. The element's best practice expects shipment tracking and tracing and that is exactly what RFID technology and the example application provides. There is no need to print new barcode or visual labels onto units, instead, the new destination is electronically changed on the smart label. The label has information on the quality requirements of the destination press. The moment a reel is dropped or subjected to excessive external pressure and the level of quality falls below that required, the reel could be fixed at once or re-routed to a destination with less sensitive press equipment. The third possibility could be for the reel to be discarded. All this is possible long before the product reaches the customer, which of course results in better service, but also cuts down the amount of unnecessary work. Then again, the exceptionality and customer dependency of each order limits the re-routing possibilities in the paper delivery chain.

**D1.8 Receive Product at Warehouse**: The RFID smart labels of each unit are read automatically at the reception and the information is saved in the inventory system. This procedure corresponds prefectly with the SCOR model best practice.
**D1.9 Pick Product**: The forklift reader recognizes right reel or pallet from its smart label. The destination and delivery date information on the label will be confirmed.
**D1.10 Load Vehicle, Generate Shipping Documents, Verify Credit & Ship Product**: The processes of loading the vehicle and generating shipping documents will be automated when the information can be transferred from the smart labels wirelessly to the system of the transportation unit. The following two best practices are realized: electronic generation and download of shipping documents, shipment tracking. (SCC, 2000, p. 138) Neither of these have identified features and, therefore, the wireless application actually gives an opportunity to improve the SCOR –model. The product shipment itself is described in appendix III.

At the customer end the RFID smart labels would benefit the printing press greatly. It is rather promising that the customers have shown genuine interest in the application. The elements of receiving, verifying and installing the product (**D1.11** and **D1.12**) would be automated. Not many best practices are defined for these two elements.

Therefore, the application could possibly bring something new to the SCOR model. Especially the availability of dynamic up-to-date quality information is beneficial for the quality inspection. It could be used to check, immediately on arrival, whether or not the product is in good enough a shape to be even run in the press and if so, at what speed. Smart labels also provide the possibility of automating the gathering of point-of-use data as each reel is scanned with a reader when taken in for printing. In this way, the supply chain can be provided with real-time information on the paper consumption of the printing press. The supply chain could, furthermore, give up of the sub-optimal practice of warehousing orders close to the customer. Instead the deliveries would reach the customer just in time.

The key concept that is recognized as being the best practice of the D1 process is responsiveness. (SCC, 2000, p. 128) In conclusion, the process analysis revealed that the delivery tracking application would bring structural changes to the supply chain and would make the delivery process more responsive in many phases.

### 7.5.5 Logistics Costs Trade-Off Analysis

The delivery tracking application can be estimated to have effects on most cost elements of the logistics costs trade-off model presented in the theoritical section of the study. The categories are explained in brief when necessary. The analysis then takes each cost category and lists the obvious and potential increases, investments and savings (direct and indirect) that occur when the wireless delivery tracking application is implemented. The costs are seen from the paper manufacturer's point of view, although the whole supply chain is kept in mind in order to avoid sub-optimal conclusions.

**Transportation Costs**

- *Increases*: A new RFID infrastructure will be needed. RFID technology investments will be, in part, an indirect cost through contracts with the logistic providers.
- *Savings*: Less transported ton kilometers due to better organized, optimized, and controlled deliveries.

**Warehousing Costs**

Warehousing costs are comprised of two distinct categories. Fixed throughput costs come from running the warehouse and include, for instance, the costs associated with the facilities, equipment and labor. Storage costs vary according to inventory level and are actually included in the inventory carrying costs.

- *Increases*: RFID technology investments will be required from the warehousing service providers. It can effect the paper manufacturer indirectly either way once the contracts are adjusted.
- *Savings*: Less lost units. More efficient use of labor through automated shipment checking. Less errors, waste, and damaged goods thanks to automated forklift checking and operating functions.

**Order Processing and Information Costs**

These include all the costs for issuing and closing orders, the related handling costs, and associated communication costs.

- *Increases*: Investments in RFID technology and building interfaces to existing IT systems.
- *Savings*: More effective information sharing resulting in less time spent in phone calls between different parties of the supply chain. Real-time information delivery at automated shipment handling will also bring savings.

**Production Lot Quantity Costs**

Consist of production preparation costs (setups, inspections, etc.), lost capacity due to changeover, materials handling, scheduling, and expediting. These costs usually change as the distribution system changes.

- *Increases*: Presumably the delivery tracking application doesn't impose any changes on the production scheduling. Consequently no increases in the production lot quantity costs would be expected.
- *Savings*: Most likely there would be no savings either.

**Inventory Carrying Costs**

Only those costs that vary with the level of stored inventory are included. Holding inventory ties up money and, thus, the capital cost is the biggest cost category of carrying inventory. Other cost categories include inventory service costs (taxes and insurances), storage space costs and inventory risk costs (obsolescence, damage, pilferage, relocation).

- *Increases*: No expected increases in inventory carrying costs.
- *Savings*: The more controlled and optimized supply chain and transparent view of all the inventory in the chain can considerably cut down the overall inventory. Noticeably less inventory is carried if the orders are delivered directly to customer and not held at warehouses or distribution centers. The effect is cumulative since service and storage space costs will drop down. Similarly the risks are decreased as the traceability of damaged products is possible.

In addition to direct and indirect savings the delivery tracking application will bring numerous intangible benefits. As the theory suggested, the investments will ultimately cause increase in the service levels perceived by the customers. (Robeson and Copacino, 1994, pp. 271-277)

## 7.6 A SWOT Analysis of the Application

To summarize the key characteristics and concerns of the delivery tracking application, a SWOTanalysis was conducted. The analysis combines in one table the key strengths and opportunities that prove the importance of the application, weaknesses that need to be worked on, and the threaths that should be eliminated.

Table 7. The SWOT analysis of the case application.

| **Strengths** | **Weaknesses** |
| --- | --- |
| • High wireless quotient<br>• Strategically significant<br>• Superior technological capabilities | • UHF range technology still under development<br>• Strict transmit power regulations |
| **Opportunities** | **Threats** |
| • Worldwide standard<br>• Swift technology diffusion and price deductions | • Passivity of critical parties<br>• New replacing technologies |

The loosening of transmitting power regulations is already under way. Also, research by VTT has entailed good results for the use of UHF-range technology in RFID applications. Thus, the weaknesses listed above shouldn't be an insuperable hurdle for realizing the application, whereas the threats are more complex questions. Assuring the involvement of the relevant interest groups within the whole cluster is imperative. The problem arises from motivating the parties that might end up having to make the largest investments but with the fewest direct benefits. The scenarios surrounding the technology replacement seem quite unrealistic in the foreseeable future. Bluetooth technology becoming more common can create competitive setting between the two technologies in some application areas. Since delivery tracking requires passive technology, Bluetooth is practically out of the question. Currently, there is no threat of other replacing technologies on the horizon.

# 8. Future Visions

Hopefully, this thesis has provided new openings from which supplementary study topics might arise. It is already certain that the study will be exploited within the project when the presented theory is put into practical use. The evaluation and development process model and the use of AHP model will be tested further in practice. The first substantiation of this is a publication based on the model presented in the thesis. A conference proceedings paper to EMAC conference (Sissonen et al., 2002) was prepared and in all probability will be presented in Portugal.

The real effects of the wireless e-business applications on logistics will become more evident once the application development in the companies reaches the level of implementation and employment. Environmental impacts will be among topics that will attract increasing interest in the future. This chapter attempts to describe some visions of how the wireless applications and their effects on business structures and environment might progress.

## 8.1 The Evolution of Wireless Applications

When making strategic decisions concerning the wireless technology the decisions should be based as much on future trends as they are on today's technology. The evolution of wireless Internet will be as unpredictable as that of its fixed counterpart has been. The most beneficial killer applications have turned out to be something very different from what was expected. This is why the progress of enabling technologies and new solutions should be closely followed. However, the development will not only be dependent on the framework given by future technologies, but also on the possibilities and limitations of back-end systems. (Paavilainen, 2001, p. 39)

### 8.1.1 The Future of Wireless Technology

The development of wireless technology will give some direction and set the pace for the evolution of wireless e-business applications. A key element that will have a strong effect on the wireless device performance is the progress in semiconductor technology. Smaller chips, less weight and power consumption, more memory and processing power etc. Still, it is likely that the size of a mobile terminal is going to be increased. Better equipped devices will enable more attractive applications. A bigger screen and more flexible input methods are required by many wireless e-business applications. (Paavilainen, 2001, p. 45)

### 8.1.2 A Potential Emerging Wireless Application

"A number of companies are working on flexible display technologies. This development could fundamentally change the way we interact with devices." (Sharma, 2001, p. 177) Combined with an intelligent mobile agent technology that could automatically download the news that are identified in user profile, there is a possibility of using the flexible display as a re-usable daily 'newspaper'. This is something that will definitely interest the paper industry. The digital re-usable newspaper is an example of a wireless e-business service application that represents the 'pull information' -phase of the mobile services development presented below. In the future also the payment for the service will be carried out on location through the application as the following figure depicts.

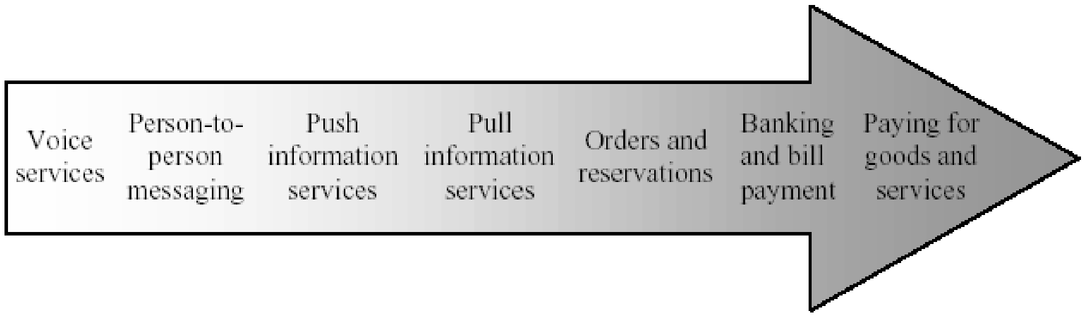


Figure 29. The phased development of mobile services. (Bond and Williams, 2000, p. 4)

One must keep in mind that wireless e-business development in the near future will be quite rocky. There are still several unsolved issues such as device form factors, competing operating systems, roaming, privacy in location-based services, security concerns, synchronization issues, interoperability concerns, wireless device hand-overs, electromagnetic radiation issues and social etiquette that will have to be looked into. (Parker and McQueen, 2001, p. 10)

## 8.2 New Business Models in Paper Industry

Wireless e-business that is emerging from the convergence of e-business and mobility will create opportunities for innovating radically new ways of doing business. “As would be expected in such a complex new undertaking, there are many factors driving and shaping the emerging wireless Internet business models. New takes on value propositions, customer expectations, technological infrastructures, convergence-based partnerships and any number of other factors are driving companies back to square one, from where they are being forced to re-think the basics.” (XSVoice, 2001, p. 2) One of the main objectives of the project is to study this phenomenon. The new paper industry business models haven’t been contemplated in this thesis, nevertheless, here is a short look at the subject from the perspective of RFID.

In the example application introduced in the thesis, the RFID technology brings incremental improvements to the business, but it also opens up new radical possibilities for the paper industry.

| | Component | **System** |
|---|---|---|
| **Radical** | Nonlinear Innovation | **Business Concept Innovation** |
| **Incremental** | Continuous Improvement | **Business Process Improvement** |

Figure 30. Beyond continuous improvement. Redrawn from (Hamel, 2000, p. 18)

As presented earlier, the RFID technology can be used to refine internal and supply chain performance, but also to bring new innovative products to market and business concepts for the companies. This has been noted: The International Paper announced a technology alliance with a RFID manufacturer Micromem Technologies (Micromem, 2001) and UPM-Kymmene has its subsidiary Rafsec that produces RFID smart labels. The commercialization of packaging materials fitted with smart labels is apparently on the way and the potential markets seem unrestricted. The future will show how radical changes the new business models will bring to the market. There seems to be a definite need for drastic measures since the current paper industry strategy paths of consolidation and cost-cutting seem to reaching a dead end.

## 8.3 A Brief Look at Environmental Perspectives

The significance of environmental issues is on an upsurge. Environmentally unethical business practice will not only inflict problems on company's image, morale and shareholder value but will also be an imminent threat to the sustainability of the entities beyond the company. Today, there is a clear need for pre-emptive action from the companies. This subchapter takes a brief look at how the environmental legislation and especially the changes in the common consumer awareness and values are transforming the business methods. On a more exact level the ecological effects of the wireless technology boom is discussed.

### 8.3.1 Consumer Awareness and Legislation

"The legislation is very much a response to growing public concern for environmental matters. [..] This has prompted the need for visible and timely initiatives on the part of manufacturers and suppliers. There are distinct parallels here with lean thinking and the concept of 'more from less'. The goal is to develop and deliver a value proposition to the customer that triggers a positive environmental response and a clear propensity to purchase." (Hughes et al., 1998, pp. 173-174) In order to take this initiative across the whole supply chain common policies towards the environment and ecological performance indicators need to be developed. Companies listening to their customers will require environmental certifications from their suppliers. (Skjoett-Larsen, 2000, pp. 384-385) In this way, the environmental impact is felt through the whole supply chain.

### 8.3.2 Green Wireless Technology

"In general, the integration of technological change in consumption dynamics contributes to growth in material consumption…" (Røpke, 2001, p. 418) As the wireless technology is reaching the masses, it is also transforming from a luxury item, that only the management gets to embrace, into a commodity that serves the entire workforce. The pace of evolution familiar from the computer technology is true to wireless devices too and is causing the technology to be frequently replaced. This is why environmental sustainability, such as disassembly and raw material usage considerations, should be designed into the product. The product life cycle should also incorporate the usage, disposal and recycling. (Hughes et al., 1998, pp. 174-175)

The concept of reverse logistics is applied in processes connected with recycling, reusing and reducing the amount of materials used. "Reverse logistics will be an important issue in future, both for the companies that are going to organise the recycling systems and for the companies that have to pay for the disposal of run-down or waste products. Reverse logistics start in the product development phase, where it is important to consider which materials to use in production in order to minimise consumption of materials and the costs of a later separation and recycling of components." (Skjoett-Larsen, 2000, p. 385)

Wireless technologies may also bring some answers to the reverse logistics issue. An example of such a solution is the aforementioned RFID label technology. "Information derived from the tag could help to manage the reuse, recycling or disposal of the material. This could be done either by looking up the details of the packaging from the product identity or by carrying explicit information on the tag." (EAN.UCC, 1999, p. 19)

### 8.3.3 The Porter Hypothesis

The changes in processes due to environmental regulations are often seen as obligatory additional costs. However, as the company is driven by the regulations to innovate environmentally fit products and processes, there is a theoretically proven possibility of simultaneous pollution alleviation and productivity benefits. (Mohr, 2000, p. 9) This is the so-called Porter hypothesis that, in other words, suggests a win-win situation in the sense that environmental policy improves both environment and competitiveness. (Porter, 1990) The increased customer-driven interest in the environment may result in a shift of trends towards more localized market structures where logistics minimization is the key source of competitive advantage.

# 9. Summary

The goal of this study was to develop and to test a process model for selecting the most promising wireless e-business application ideas, and then further analyse the outcomes of the process. Particularly the idea with the best strategic and technological capabilities was studied.

The theoretical study combines research from different fields in order to see the topic in the light of a set context, a considerable research effort was required in several varied issues which include wireless e-business, its applications and value drivers, wireless technologies, the innovation process, the characteristics of the paper industry and, more specifically, the importance of logistics function in the given industry.

The empiric contemplation of the study was covered in two overlapping layers. The first layer concentrates on the development and testing use of the process model for evaluating and developing application ideas. The second layer presents an example application that was developed using the discussed process. This application and its effects on the supply chain structure, delivery process and logistics costs were then analysed.

## 9.1 Conclusions

The innovation process constructed from screening and developing phases includes multiple complex decision making and evaluation situations that are often conducted in very unprofessional manner. The process model developed in the study corrects this malady by providing a framework for selecting wireless e-business applications.

New wireless technologies and their intelligent utilization open up new possibilities for achieving competitive advantage. RFID technology exemplifies this paradigm by adding visibility to the supply chain and streamlining the delivery process. The wireless phenomenon is progressing swiftly and will most definitely shape the world.

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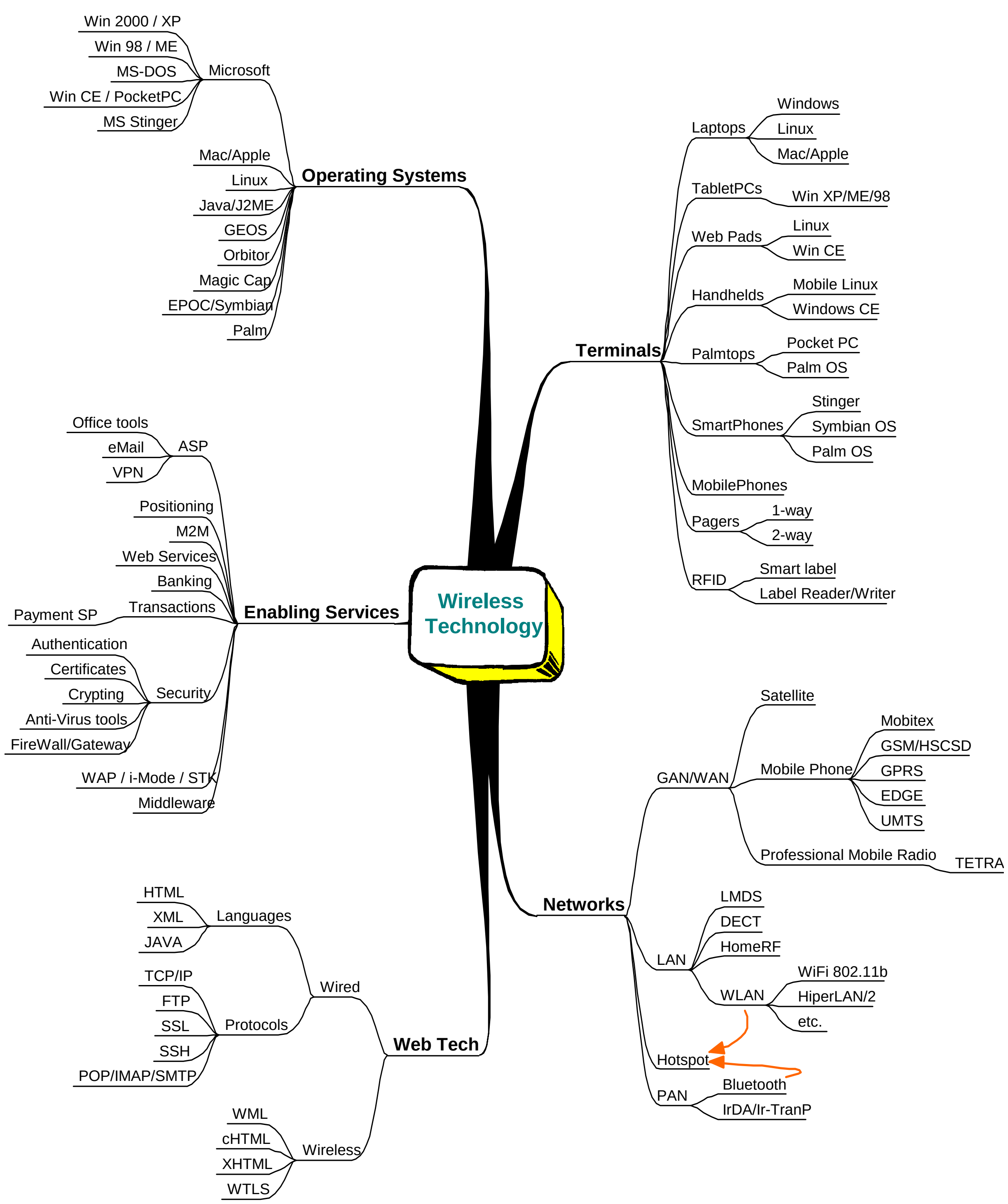
**General Internet Sources**

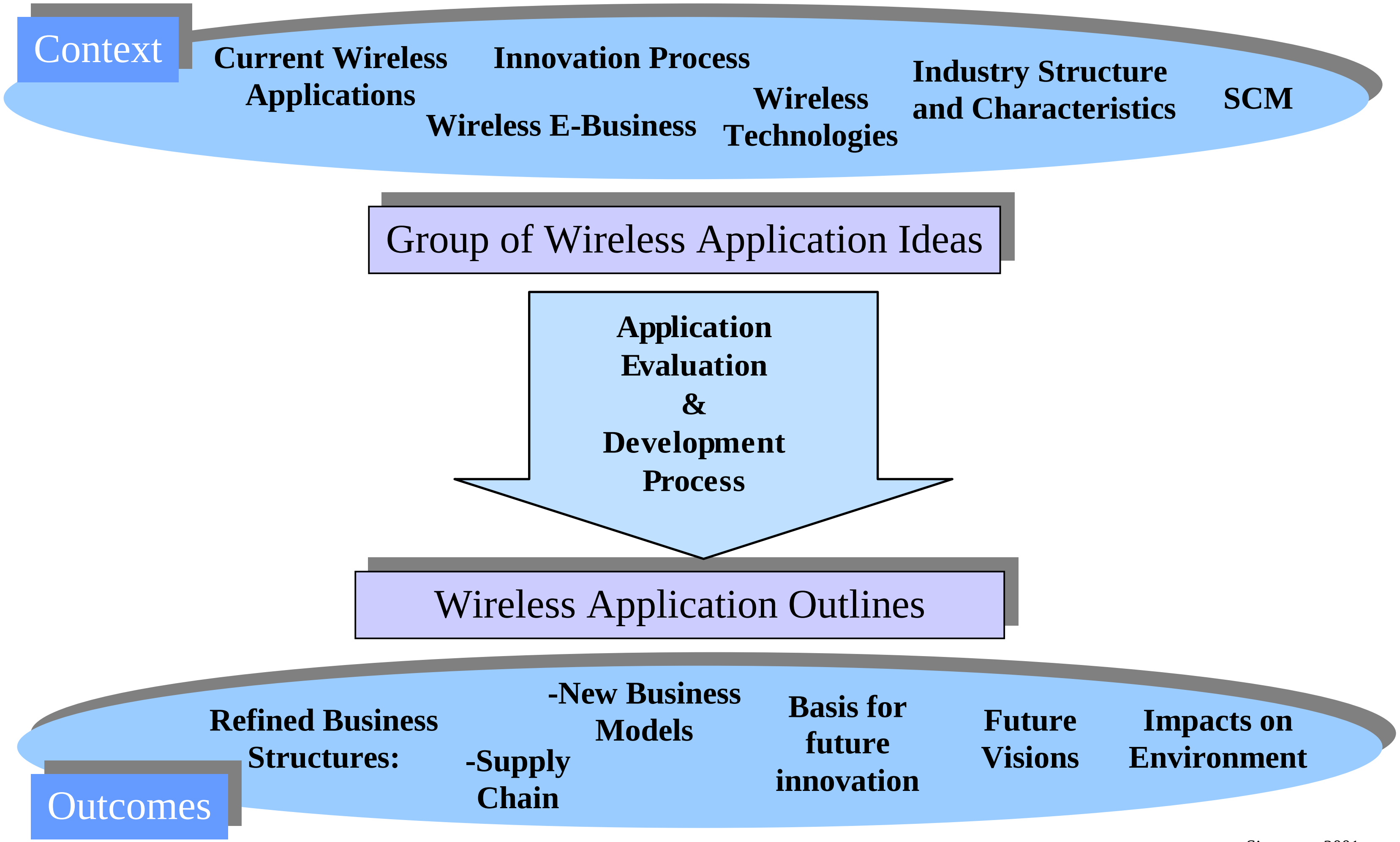
http://www.acronymfinder.com/
http://www.aimglobal.org/
http://www.ean-int.org/
http://www.google.com/
http://www.whatis.com/

Appendix I. Wireless Technology Landscape.



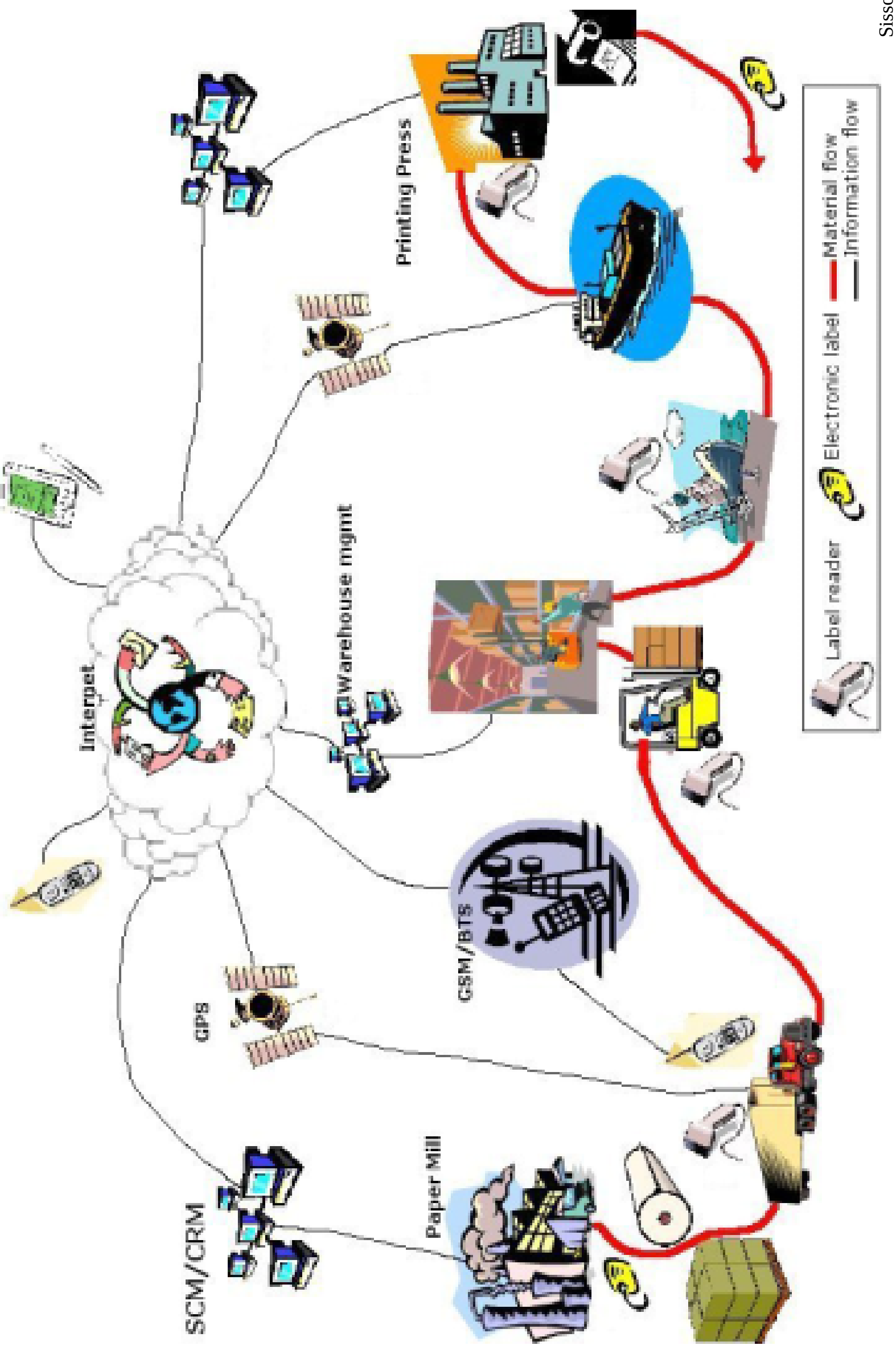

Sissonen, Komarova, Kytölä, 2001

## Appendix II. Thesis Overview.



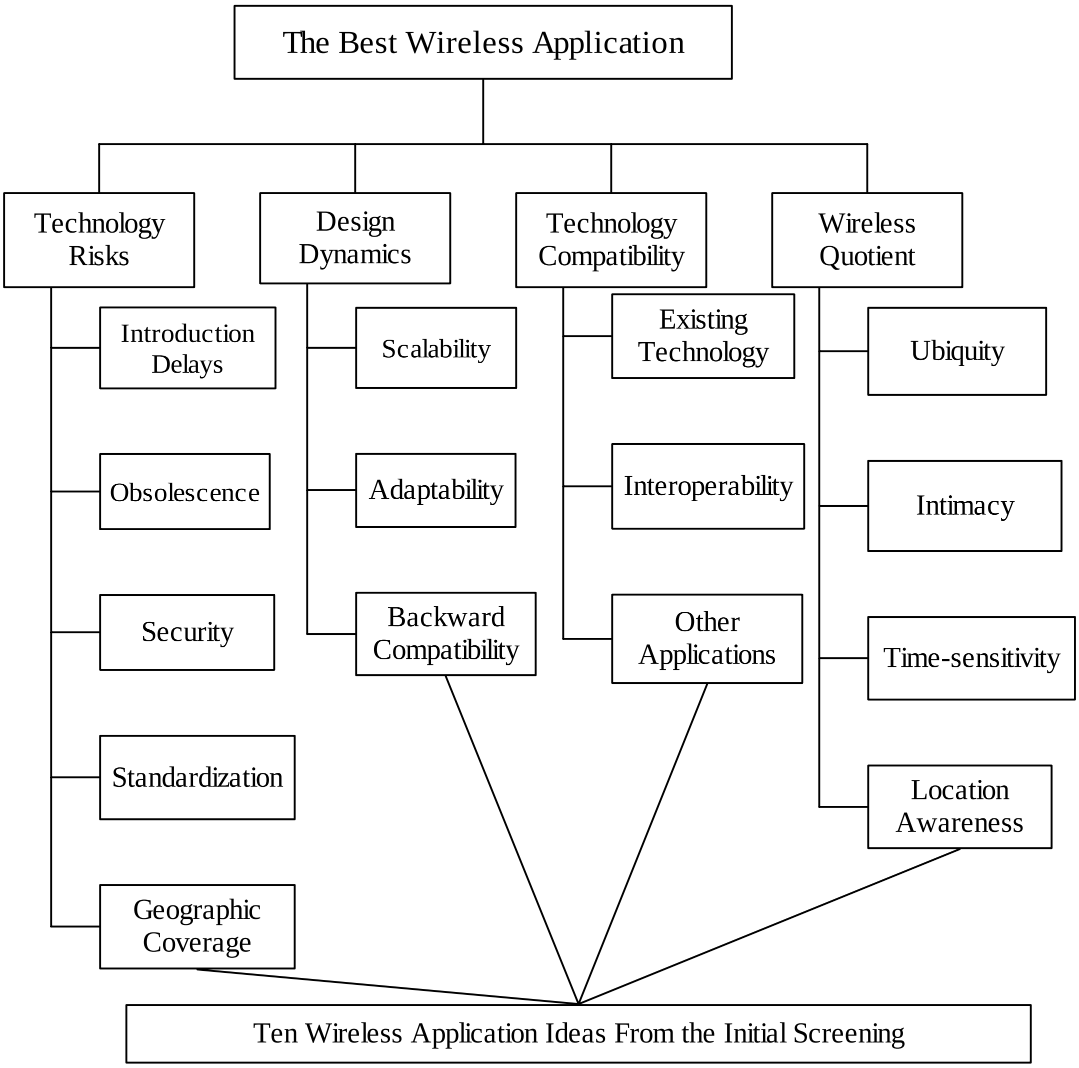

Sissonen , 2001

Appendix III. Example application, delivery tracking.




Sissonen, 2001

Appendix IV. AHP model for evaluating the wireless applications.




Sissonen, 2001

Appendix V. Acronyms.

**AHP**, Analytic Hierarchy Process

**ASP**, Application Service Provider

**B2B**, Business-to-Business

**B2C**, Business-to-Consumer

**cHTML**, Compact HTML

**CPFR**, Collaborative Planning, Forecasting and Replenishment

**CRM**, Customer Relationship Management

**CVA**, Customer value-added

**DECT**, Digital European Cordless Telephone

**DSS**, Decision Support Systems

**ECR**, Efficient Customer Response

**EDGE**, Enhanced Data for GSM Evolution

**EC**, European Commission

**ELO**, Elektronisen liiketoiminnan logistiikka

**EMAC**, European Marketing Academy

**EMI**, Electromagnetic Interference

**ERP**, Enterprise Resource Planning

**ETO**, Engineer-to-Order

**FTP**, File Transfer Protocol

**GAN**, Global Area Network

**GDSS**, Group Decision Support System

**GPRS**, General Packet Radio Service

**GSM**, Global System for Mobile Communication

**GTIN**, Global Trade Item Number

**HF**, High Frequency

**HiperLAN**, High Performance LAN

**HomeRF**, Home Radio Frequency

**HSCSD**, High Speed Circuit Switched Data

**HTML**, Hyper Text Mark-up Language

**IC**, Integrated Circuit

**ICT**, Information and Communications Technology

**IMAP**, Internet Message Access Protocol

**IP**, Internet Protocol

**IPD**, Intelligent Paper Delivery

**IPv6**, Internet Protocol version 6

**IrDA**, Infrared Data Association

**ISC**, Intelligent Supply Chain

**IT**, Information Technology

**LF**, Low Frequency

**LAN**, Local Area Network

**LMDS**, Local Multipoint Distribution Service

**µW**, Microwave

**MIT**, Massachusetts Institute of Technology

**mp3**, MPEG-1 Audio Layer-3

**MS-DOS**, Microsoft Disk Operating System

**MTO**, Make-to-Order

**MTS**, Make-to-Stock

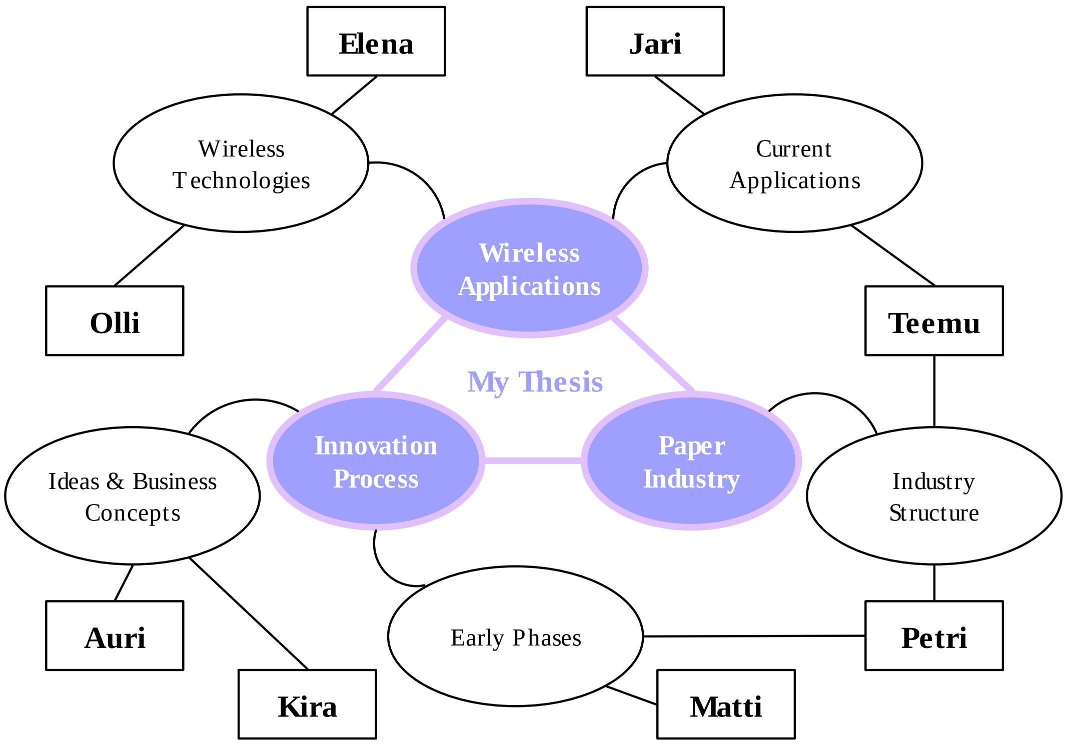
**M2M**, Machine-to-Machine

**NPD**, New Product Development

**OS**, Operating System

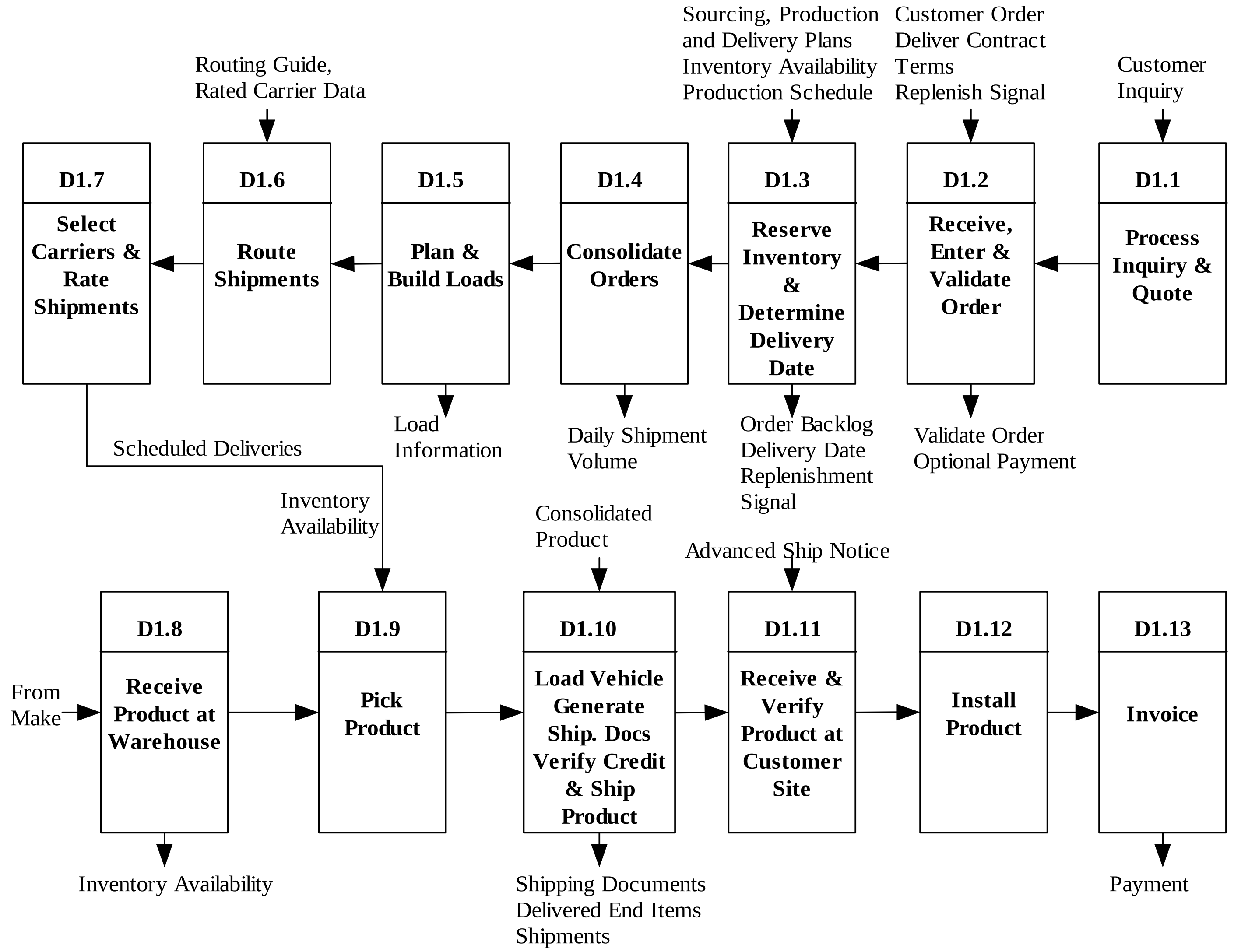
**PALOMAR**, Passive long distance multiple access high radio frequency identification system
**PAN**, Personal Area Network
**PDA**, Personal Digital Assistant
**PIM**, Personal Information Management
**POD**, Port of Destination
**POL**, Port of Loading
**POP**, Post Office Protocol
**P2P**, Person-to-Person
**RFID**, Radio Frequency Identification
**ROI**, Return On Investment
**R/W**, Read/Write
**SCC**, Supply Chain Council
**SCM**, Supply Chain Management
**SCOR**, Supply Chain Operations Reference
**SIM**, Subscriber Identification Module
**SMS**, Short Message Service
**SMTP**, Simple Mail Transfer Protocol
**SSCC**, Serial Shipping Container Code
**SSH**, Secured Shell
**SSL**, Secure Socket Layer
**STK**, SIM Tool Kit
**SWOT**, Strengths, Weaknesses, Opportunities, Threaths
**TBRC**, Telecom Business Research Center
**TCP/IP**, Transmission Control Protocol/Internet Protocol
**TETRA**, Terrestrial Trunked Radio
**UCC**, Uniform Code Council
**UHF**, Ultra High Frequency
**UM**, Unfied Messaging
**UMTS**, Universal Mobile Telephone System
**VALO**, Verkostojen ajantasainen logistiikka
**VIPRO**, paperiteollisuuden vientiprosessien kehittämisprojekti
**VMI**, Vendor Managed Inventory
**VPN**, Virtual Private Network
**VTT**, Valtion teknillinen tutkimus-keskus (Technical Research Centre of Finland)
**WAP**, Wireless Application Protocol
**WiFi**, Wireless Fidelity
**WAN**, Wide Area Network
**WLAN**, Wireless LAN
**WML**, Wireless Mark-up Language
**WTLS**, Wireless Transport Layer Security
**XHTML**, Extensible HTML
**XML**, Extensible Markup Language

Appendix VI. The Master's Thesis in relation to others in the project.




The full names and the subjects of the persons listed in the figure are:

- Elena Komarova, wireless networks and terminals
- Jari Korppas, current wireless applications in ICT cluster
- Teemu Hiltunen, current wireless applications in forest cluster
- Petri Suikki, benefit analysis of wireless applications in forest cluster
- Matti Laaksonen, early phases of innovation process
- Kira Lopperi, business models
- Auri Määttä, real options
- Olli Kytölä, enabling services




Appendix VII. SCOR –model, D1: Deliver Stocked Product