

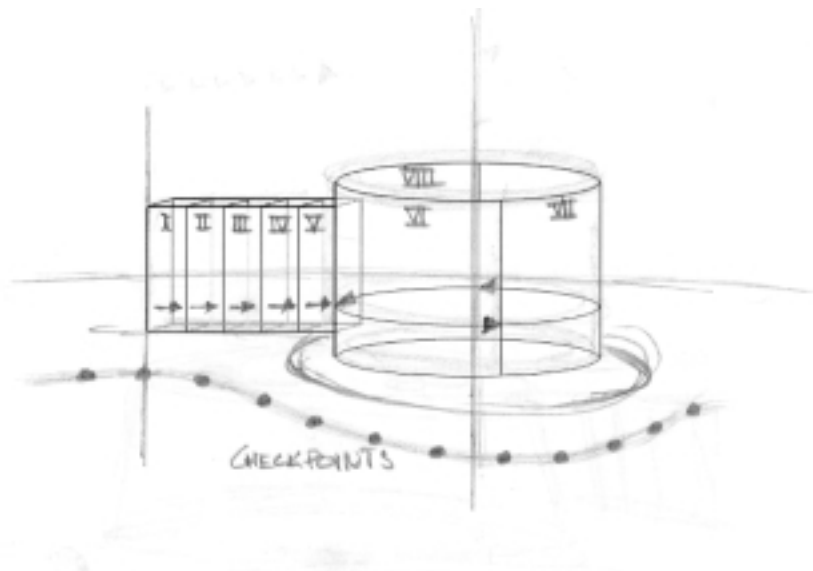


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Developing Wapps

- Wireless Applications in the Context of Systems Development -



Master thesis, 2001
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Abstract

This thesis investigates the process of developing wireless applications (wapps) that are tailored to meet the unique demands of the mobile market place. This thesis topic was conceived when the authors observed negative press articles about adoption problems in the market, many of which resulted from poor application design. These observations provided the motivation necessary to improve the functionality and viability of wapps by creating an optimised structured application development process that encompasses the unique requirements of the mobile market place. The investigation consisted of the following: an action-research study performed at Ericsson, and five qualitative interviews with industry experts. The work resulted in the identification of numerous critical project success factors and development considerations, which indicate that the development process is a determinant of how wapps are seen by users and critics. The critical project success factors are amalgamated in a recommended systems development model, which aims at supporting the developer and serving as a tool for developing killer wapps.

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Lastly, our thanks to the interview respondents, Didier Chincholle, Bo Dahlbom, Magnus Ewert, Johan Hjelm, and Mattias Olofsson, for their valuable contributions to the thesis.

Göteborg, 17th of May 2001

Vilhelm Brag

Robert Wentrup

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1 Introduction

1.1 Problem area

In the recent couple of years a lot of books and articles have been written about the concept of *Wireless Application Protocol*, better known as WAP. The majority of the articles have been focused on the various limits with the WAP technology, such as devices suffering from limited processing power and memory, small displays, limited bandwidth and connection speeds, etc. Headlines like *WAP is a flop* and *Mobile Internet – the next bubble to burst?* have covered computer magazines and clearly expressed the scepticism surrounding this wireless technology.¹ Experts claim that *wrong approach to portability* would be a better short for WAP, thus pointing at the weak usability and bad design of WAP applications and WAP devices on the market today.² The critics wonder: Have the visions of wireless communication began to fade? Will there be anything in it at all for the consumer to have a WAP phone in the future? Will the WAP technology be delimited to services such as alerting train schedules and stock prices?

Meanwhile, and in contrast to the critics' scepticism, innumerable books have been published on topics like *How to develop WAP-applications*. These books, in which the first chapters normally give the reader a detailed explanation about the wireless application protocol followed by chapters of instructions on how to use WML and WML-script (the two programming languages associated with WAP), have almost been written as cookbooks on how to design wireless applications.³ Some books have also touched the areas of "what to have in mind when developing WAP-applications", bringing up suggestions like: avoiding a lot of text, reducing bytes, considering the many browsers, etc.

Nevertheless, the number of WAP developers is today growing in an enormous pace and the companies offering "wireless solutions" is more and more becoming a common feature on the computer service market. New WAP-terminals and new network systems are emerging, thus making way for new solutions and new possibilities for mobile users. Does the WAP future still look bright? Is the WAP technology after all just at the first stop of a long and never-ending journey?

The above mentioned have undoubtedly been the hottest areas for WAP publications during the past two years. This thesis, however, does not directly deal with any of these specific topics, although they are very much related to our work. More precisely, we have in our thesis tried to put WAP into the context of systems

¹ We refer to a range of articles published in public press during 2000 and 2001. For example: In Computer Sweden (www.computersweden.se): *Nielsen dömer ut mobilt internet* (010110), *Gates sågar wap* (000912), *Utvecklare tveksamma till mobilt internet* (001108), *Webbguru sågar wap* (001201) In Wired News (www.wired.com) : *Combating WAP's Bad Rap* (Elisa Batista), (010319), *A Growing Epidemic of 'Waplash'*, Elisa Batista, (001226). See also Appendix 8.1: *Problem area: Is WAP a flop?*.

² Nielsens alertbox, *WAP Backflash*, Jacob Nielsen, (www.useit.com/alertbox/20000709.html)

³ We refer to a range of books published lately. For example: *Programming applications with the Wireless Application Protocol* by Steve Mann, *WAP development with WML and WML-script* by Ben Forta et al, *Getting started with WAP applications using WML* by Huw Evans et al, *Professional WAP* by Charles Arehart, et al, *Wireless web development* by Ray Rischpater, *Inside WAP : programming applications with WML and WML-script* by Pekka Niskanen etc.

development and tried to focus on the development process of wireless applications (wapps). Furthermore, we have tried to identify the major crucial stages in the development process of wapps, and tried to explore how the process of developing wapps may differ from traditional application development. Lastly, but importantly, we have tried to discover the major philosophical and practical traps related to WAP development, thus affecting the quality of WAP usage. We have asked ourselves if it even could be so that the criticism to WAP, regarding weak usability and bad design, has its origin in the development process of wapps? And if so, how could the development process and its focus be re-designed and changed, and even optimised, in order to improve the quality of wapps for the user and thus result in “killer wapps”?

The WAP criticism, leading to our raised questions at issue, has been the underlying incentive for this thesis. Up today little research has been done within this area, in our opinion mainly due the relative young age of WAP technology, but also due to the fact that WAP development is often considered being a very practical process, a process that *can* be handled without the need of general theoretical models. Of course, it is well known that there are a lot of things to consider when developing wapps, and many experts do have a lot to say about this. But the question for us is more about finding out *when* in the development process to consider *what* – to put the right consideration in the right place along the chain of systems development.

In the role of informatics students, we felt it would be very interesting to put a more academical and theoretical touch in this area, and combine the field of systems development with the field of wireless development in our thesis work.

1.2 Problem definition

The background to our problem definition was discussed above in *Problem area*. There we explained our desire of investigating if the criticism to WAP has its origin in the development process, and if so, how the development process of wapps could be changed and designed in order to improve the quality of wapps for the user.

Accordingly, the narrow problem definition of the thesis is to *investigate how a development model can be designed, in order to support the wireless application developer in the development process, and to be a tool for developing quality wireless applications, killer wapps*.

If you split the problem definition into two parts it is fairly easy to identify two different perspectives of the problem. The first part of the problem definition, “...*investigate how a development model can be designed in order to support the WAP application developer in the development process..*”, deals with the *developer’s* perspective while the second part, “...*and to be a tool for developing quality wireless applications, killer wapps*”, in addition to the developers’ perspective also deals with the *user’s* perspective.

In our thesis we have focused on the developer’s perspective, but without neglecting the user’s. When defining the term “quality wireless applications” we did this by including user’s point of view. In our opinion a quality application seen from a user’s perspective has a strong correlation with what is seen as a quality application from a developer’s point of view. A systems developer’s main mission should after all be to

make the world a better place for the user by striving for quality, at least this would be ideal from a philosophical informatics perspective.⁴ Yet, to define this term “quality wireless applications” is a very complex task and much indeed a very subjective matter, and something we will not go further into. In “Delimitations” we have defined what *we* mean with quality applications, thus excluding all other definitions of this term.

We find it important for the reader to be aware of the distinction between these two perspectives, although they are in many ways overlapping and the boundaries between them sometimes tend to be quite fuzzy.

1.3 Purpose

The general purpose of the thesis was to deal with the above mentioned problem by studying relevant literature and by conducting two different studies. The first was an action research study, where we developed a simple WAP application and did an analysis of our work. The second was a qualitative study, where we conducted qualitative interviews with experts within the fields of systems development, mobile informatics, and WAP, and got deeper into the area of WAP development and usage. Having done these studies we summarized our result and thereafter came to a definite conclusion based on our findings – a wireless application development model.

1.4 Objectives

The thesis primary objective was for us to get better understanding of the problem area in order to create a wireless application development model based on the results from the studies. A secondary, indirect objective was for our model to be useful in the future process of wireless application development of quality wapps.

1.5 Course of action

In order to fulfil the purpose and to reach our desired objectives we took the following course of action:

- Studied relevant literature about systems development and WAP development
- Conducted an action research study: developed a WAP application in order to get insight in the WAP application development process.
- Conducted a qualitative study: interviewed professional experts within WAP and systems development in order to deepen our insight into the problem area.

This course of action with the three folded input channels constituted a solid platform for us to cover the problem area and to reach our desired objectives.

⁴ Bo Dahlbom, Lars Mathiassen, *Computers in context*, (Oxford: Blackwell Publishers Inc, 1999) 135 ff

The course of action of this thesis is illustrated in the figure below.

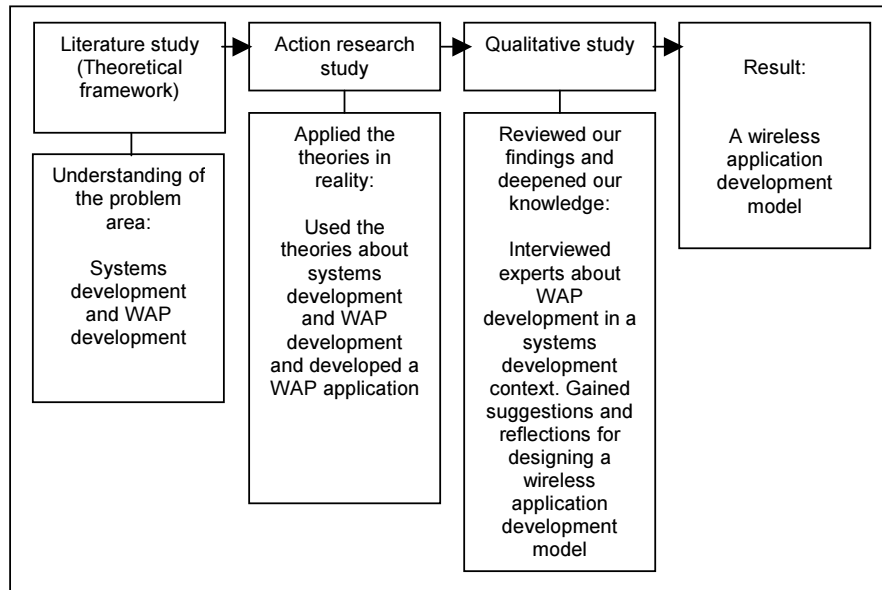


Figure 1-0

The course of action of the thesis

The thesis investigation can be divided into three major steps: literature-, practical-, and qualitative study.

The table below is a complement to the figure above and visualizes the course of action taking the problem definition into account.

Problem definition	Activity performed to solve the problem	Deliverable
How can a development model be designed in order to support the wireless application developer in the development process, and to be a tool for developing quality wireless applications, killer wapps?	Dealt with systems development and WAP development in the theoretical framework. Conducted one action research- and one qualitative study within the field of WAP development. Drew conclusions from the two studies in the thesis.	A wireless application development model

Table 1-1

1.6 Delimitations

We divided our delimitations into four main categories: *Definitions*, *Target group of readers*, *Areas*, and *Size of the study*.

1.6.1 Definitions

- Wapps

The two terms *wireless applications* and *WAP applications* are in reality (and so also in this thesis) used synonymous. With WAP applications, we mean *wireless applications* (wapps), *associated with the Mobile Internet*, and in our case, the WAP protocol stack. Wireless applications can, however, run on other protocols as well.

WAP (Wireless Application Protocol), is a definition of the protocol stack used for the communication of wireless applications. By the term WAP applications, we do not mean WAP telephone specific applications, such as applications written to control and manage the telephone device, etc.

In the action research study in our thesis we developed a WAP application (= a single wapp). Although some might argue that this is actually a *WAP prototype* we chose to use the word WAP application due to the fact that this thesis focus on the development of applications, not on the process of prototyping.

- The client in WAP communication

With a mobile device we mean the client in the WAP communication, i.e. WAP mobile phones. All the terms *mobile cellular*, *mobile device*, *handheld device*, *mobile phone*, *mobile unit*, and *WAP-terminal*, go under this definition.

- Systems development

According to literature, systems development is often strongly related to organizational change, (e.g. a company wants a new information system to fit to their organizational changes).⁵ This thesis focus on the isolated system development process, the application development process (analysis, design, realization, implementation) rather than on systems development in an organizational context (change analysis).

- Quality applications

In our thesis we have made a very broad definition of *quality applications*. By a quality application we mean an application with a functional value (meaningful), a usability value (easy to use), and a technical value (easy to maintain for the developer).⁶

⁵ Erling S Andersen, *Systemutveckling – principer, metoder och tekniker*, (Lund: Studentlitteratur, 1994) 40 ff

⁶ According to Dahlbom/Matthiassen (*Computers in context*, 1999) “quality has to be thought of as a challenge, something to be strived for but never reached “. Eklund, Fernlund (*Programkonstruktion med kvalitet*, 1998) refers to the ISO standard (ISO 8402): “The totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs”.

Both Dahlbom/Matthiassen and Eklund/Fernlund argue that quality is often measured with the following factors: correctness, reliability, efficiency, integrity, usability, maintainability, testability, flexibility, portability, reusability, and interoperability.

1.6.2 Target group of readers

We want to delimit the target group of this thesis to readers who have general knowledge of information technology and systems development, and also have an idea of what WAP is. In our thesis we therefore will not explain matters of course (at least for people with existing computer interest) as the Internet, mobile devices, data communication, etc. Nor will we on the other hand go too far into detail of technical matters. To summarize, we assume the readers of this thesis are aware of elementary terms related to information technology and systems development, and consequently keep the technical level of the content correspondingly to this presumption.

1.6.3 Areas

Although this thesis deals with wireless applications and WAP there are certain areas that will not be emphasized upon:

- **Consumer aspects of wireless applications and WAP**
The thesis will not focus on matters like: What services do the consumers require? Which are the most common alternatives to WAP?
- **Markets aspects of wireless applications and WAP**
The thesis will not focus on matters like: What are critical success factors for mobile internet companies?
- **Technical aspects of wireless applications and WAP**
The thesis will not focus on matters like: How does the wireless protocol technically integrate with the HTTP protocol?
- **Future aspects of wireless applications and WAP**
The thesis will not focus on matters like: What is the forecast for WAP technology? How will 3G impact on WAP usability? How can I-mode and WAP be united?

1.6.4 Size of the study

Because of limited time and resources the action research study was delimited to the development process of just one WAP application. The qualitative study was delimited to five qualitative interviews.

1.7 Disposition

This thesis is divided into eight parts: Introduction, Methodology, Theoretical framework, The Studies, The Results, Discussion and Conclusion, References, and Appendix.

Part 1: **Introduction**

The chapter gives a background of the thesis project. Problem area, Problem definition, Purpose, Objectives, Course of Action, Delimitations, and Disposition are presented.

Part 2: **Methodology**

In this part we give an overall description of methodology and the applied methodology path in this thesis.

Part 3: **Theoretical framework**

Here we deal with the theoretical aspects of our thesis work and fundamentals to our studies.

Part 4: **The Studies**

The action research study and the qualitative study are presented.

Part 5: **The Results**

The results from our studies are presented in this part.

Part 6: **Discussion and Conclusion**

In this part we discuss our findings and our results, draw conclusions, and make suggestions for future research.

Part 8: **References**

References are listed.

Part 9: **Appendix**

The appendix material related to the thesis is presented in this part. A list of abbreviations is presented at the end of this chapter.

2 Methodology

In research, the choice of how to perform and undertake scientific investigations is decisive for the success and the final result.

This chapter gives a brief description of theories related to the following methodological areas; philosophical perspectives of research design, different approaches to research design, and methods for data gathering. For each one of these methodological areas the applied path for this thesis is presented.

The overall purpose of the chapter is to explain the various aspects of methodology and to present our methodological path.

We are fully aware of that our methodology chapter is relatively extensive in the aspect of being a master thesis within the academic field of informatics. We have considered this matter a lot, but decided to keep it long and profound due to the fact that we are of the opinion that the applied methodological path for this thesis is a critical success factor for the result of it. Due to the relative complexity of the methodological path, it needs to be fully and clearly expressed in order to be understood, and to be put in an adequate scientific context.

2.1 Philosophical perspectives

In order to conduct and evaluate research it is important to know what underlying assumption constitutes a valid research strategy and what research approaches are most appropriate. In literature we have found classifications of underlying method traditions in empirical science.⁷ The most common, and the ones we have chosen to bring up are: *positivism*, *systems theory*, *hermeneutics*, and *phenomenology*.

The positivists generally claim that research is legitimate only if it agrees with the reality. Everything that cannot be empirically proved such as feelings, values, religious- and political values do not belong to the scientific sphere. According to the older more strictly philosophical discussion of the positivism, good research is legitimated only if it can be empirically verified. And along with this verification there comes certain rules of how to conduct empirical investigations. The theory of positivism has also got an ideological side; everything not regarded as scientific knowledge cannot be regarded as knowledge at all and/or just as irrational knowledge.⁸

According to positivists human beings have only two sources of gaining knowledge: (1) what can be registered with human senses, and (2) what can be reasoned with human logic. In the positivistic tradition there are three ways to come to conclusions, by *induction*, *deduction* and lastly a combination of these - the *hypothetical-deductive* method.

In deduction you define a logical theoretical conclusion and tests it on reality to see if it is true. The inductive approach, on the contrary, is based on real observations from

⁷ Göran Wallén, *Vetenskapsteori och forskningsmetodik*, (Lund: Studentlitteratur, 1996), 26 ff

⁸ Wallén, 26 ff

which theoretical conclusions are drawn. The inductive and the deductive approach are presented in a figure below. In contrast to the inductive method, the hypothetically-deductive method formulates premises on hypotheses, which are possible to test. Then, by a deductive conclusion you formulate a theory about the reality. Thereafter, this theory is empirically tested. Thus, the hypothetical deductive approach uses both empiric and logic in order to come to a conclusion.

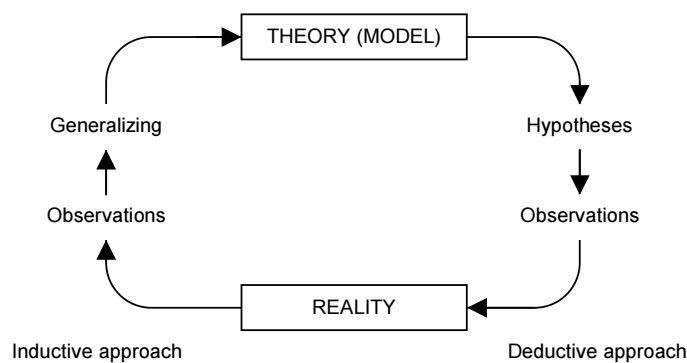


Figure 2-1 The inductive and the deductive approach⁹

Criticism to the positivistic philosophy basically states that positivism emphasizes strict rules at the expense of creativity.¹⁰

The systems theory arose partly as criticism to the positivistic theory and partly as an attempt to summarize general trends in research that were already under way within the fields of biology, technology, planning theory, etc. The systems thinking arises from a need of following, understanding, and planning for growth, and changing in complex contexts, where a number of facts interact. The systems theory is not a scientific method that could be applied on certain areas, but the opposite – a number of areas for complex interaction show common features from which the general theory grows.

A broad definition of a system is that it consists of a number of interacting objects. The system has other characteristics than what you could find in the individual objects. A more narrow definition would be that the interaction itself of the objects maintains a specific function for the system. A system can be aggregated and does not need to be physically demarcated from the environment; the systems functions do the actual delimitation the system. A precursor to the systems theory is the *ecology*¹¹ – how animals, plants, and weather interact. These questions cannot like in traditional research be studied separately or isolated where one factor is studied at time, instead they must be studied in their right context.¹²

⁹ Lars Torsten Eriksson, Finn Wiedersheim-Paul, *Att forska utreda och rapportera* (Malmö: Liber Ekonomi, 1997), 239

¹⁰ Eriksson, Wiedersheim-Paul, 201 ff

¹¹ Ecology = The science of the relationships between organisms and their environments. Also called bionomics.(www.dictionary.com)

¹² Wallén, 28 ff

Hermeneutics can roughly be translated as the school of *interpretation* - a branch of continental European philosophy concerned with human understanding and the interpretation of written texts.¹³ The hermeneutic theory has its origin from theories about interpretation of the Bible and other text documents. Today you can also identify hermeneutics overlapping with the science of semiotics¹⁴. Hermeneutics is about the interpretation of meaning. The interpretation can be everything from decoding conventions and symbols (for example traffic signs), the understanding of a “blurry” message, the interpretation of a poem, to a deeper level such as understanding the nature of human beings. Hermeneutics can also be viewed as science about communication and comprehension. In research hermeneutic philosophy often deals with sciences such as psychology, environmental analysis and artificial intelligence¹⁵, where alternatives to the positivistic theory are needed. However, the hermeneutic theory is often used as a complement rather than a substitute to positivistic research.¹⁶

Phenomenology is a school of philosophy whose principal purpose is to study the phenomena, or appearances, of human experience while attempting to suspend all consideration of their objective reality or subjective association. The phenomena studied are those experienced in various acts of consciousness, mainly cognitive or perceptual acts, but also in such acts as valuation and aesthetic appreciation. Phenomenology studies mean empirical studies about human experiences and human conception, for the purpose of being summarized in conceptions of the world or patterns of thought. In contrast to the positivistic school where the “testing” towards the outer world is essential, the phenomenology focuses on the essence of perception: “The world/the reality is for the individual what is experienced, and he/she acts on the basis of this thesis”.¹⁷ In research the school of phenomenology preferably includes working with qualitative interviews.

2.2 Applied philosophical standpoint

Several research philosophical perspectives influence our thesis as a whole. As described in the introduction of the thesis (See *Course of Action*) our thesis project consisted of three different studies: 1) The literature study¹⁸, 2) The action research study and, 3) The qualitative study.

The applied philosophical standpoints for each study made will be described in this section.

In the literature study we were most influenced by the positivistic perspective. We wanted to get a result as objective as possible in order to get a good and objective

¹³ MIT Artificial Intelligence Lab, (www.ai.mit.edu)

¹⁴ semiotics : a philosophical theory of the functions of signs and symbols (Wordnet. Princeton University, 1997)

¹⁵ MIT Artificial Intelligence Lab, (www.ai.mit.edu)

¹⁶ Wallén, 33 ff

¹⁷ Wallén, 35 ff

¹⁸ The literature study is the theoretical framework in our thesis. We have decided to define this as a study in this methodological context although some might argue that it is more an activity along the research process than a study. We agree on that the literature study was not at all an observation in the sense the action research study and the qualitative study were. None the less, we want it to be a part of our methodological path, which is why we define as a study.

understanding. Therefore, we focused on studying relevant and scientific literature with qualified academic recognition.

The action research study was also influenced by the positivistic perspective in the aspect that we wanted to get a result as objective as possible, and to understand WAP development in general more than focusing on WAP development in the context of our specific case. The action research study was very much an inductive study where we used our knowledge gained from the literature studies and put it into practise. Although we aimed to be as objective as possible it was unavoidable to be influenced by the hermeneutic perspective in the sense of how we interpreted given information and how we interacted ourselves in the development process.

The qualitative study was mostly influenced by the phenomenology philosophy. In this study we were interested of what the respondents in our qualitative interview had experienced and of their subjective valuation. The qualitative study had an inductive approach in the aspect that we did observations/interviews from the reality (to be more exact - the respondents reality) and thereafter drew conclusions from these (the conclusions were added to our accumulated virtual knowledge base). The hermeneutic perspective also had an impact in this study on how we interpreted the respondents.

2.3 Research design

2.3.1 The conventional approach

The underlying assumption in the conventional approach constitutes that there is more or less objective reality, demarcated from the human individual. Our human senses take in information about this reality and explain it by finding general laws or principles. We do this by guessing, (theories and assumptions), by testing (hypotheses or implications) or by conducting special arrangements (experiments).

The scientific attitude in the traditional school (as well as in the qualitative school, see next section) is that a thesis has to be testable to be true.¹⁹

In the conventional research approach the first step in a report is to ponder what the real problem is. The problem will impact on the choices made about theoretical approach, methods and material. The problem definition is at first supposed to be rather blurry and then gradually be polished and consequently more precise.²⁰

Problems can arise due to several occurrences; a new undiscovered phenomenon is observed, deviations between former knowledge and new observations, etc. The term *problem* viewed from a scientific perspective does not necessarily mean that something is problematic, but instead it is about which knowledge is wanted and that is formulated so clearly that it can direct the choice of methods and afterwards reveal if the answer to the problem has been reached or not. In contrast to consultant work

¹⁹ Jarl Backman, *Rapporter och uppsatser* (Lund: Studentlitteratur 1998), 23 ff

²⁰ Eriksson, Wiedersheim-Paul, 27

there must in research be requirements demanding a high degree of generality in the character of the answers.²¹

The stages along the research process are a number of activities including the problem definition. These activities should not be seen as separate, isolated processes, in fact they are often overlapping and the border between them is often fairly thin. In brief, the main activities along the research process are: the origin question, literature studies, problem definition, hypothesis, observation, analysis, interpretation, and report. The activities along the research process are visualized in the figure below.

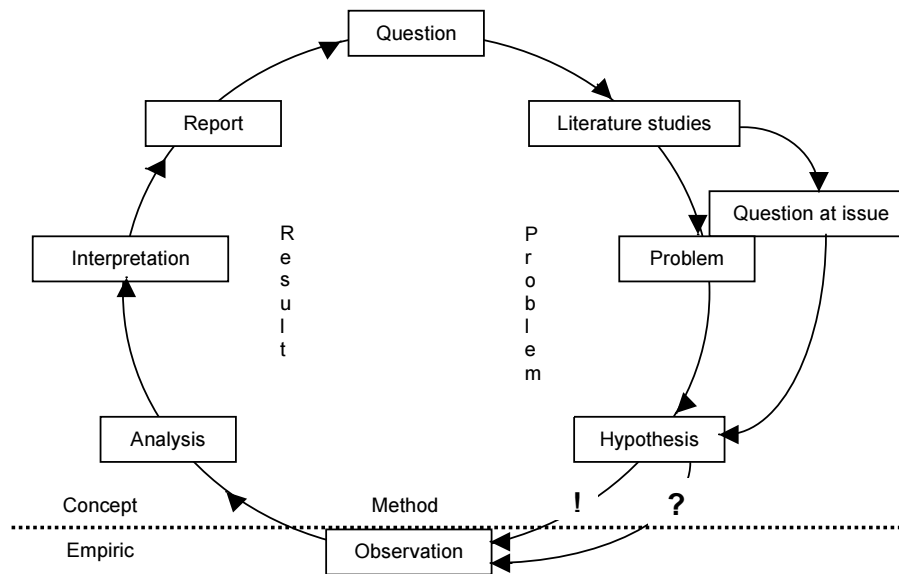


Figure 2-2 The conventional research approach (The wheel of research)²²

Depending on the knowledge level within the problem area and the degree of ambition in a project, four classifications of studies can be made.²³ The classifications are depending on how the research problem is structured and should be related to the applied philosophical research approach.²⁴ These classifications are not explicitly connected to the conventional approach, but can also be adapted on other research approaches.

- The explorative study: Conducted in order to gain knowledge about the problem variables “what”, “when”, “where”, and “in what context”. This study method is preferred when the investigator’s objective is to receive basic knowledge about a problem and is often an initial step in a series of studies.

²¹ Wallén, 45 ff

²² Backman, 23 ff

²³ Wallén, 45 ff

²⁴ Eriksson, Wiedersheim-Paul, 218

- The descriptive study: Conducted in order to determine the characteristic of the research object. Includes data gathering and systematic processes. The inductive approach is normally applied in this type of study.
- The conclusive study: Conducted in order to examine casual relationships. Tries to answer what explanation is relevant to a certain problem. This method aims to provide information evaluation of alternative courses of action and is also used when it comes to choosing a specific way of conduction.
- The normative study: Conducted in order to result in a norm-or act proposition. For example: How should an organization be designed in order to be efficient? The objective for the investigator in this approach must be to show different alternatives and their respectively consequences.

2.3.2 The qualitative approach

Qualitative studies often aim to discover the character of a phenomenon, how it should be identified etc.²⁵ The main difference between the qualitative approach and the conventional approach is that in the latter the reality is *not* viewed as objective but subjective. The reality, in the qualitative approach, is an individual, social, cultural construction. It is more important to study the human perception of the reality rather than, as in the conventional approach to study and measure a given “reality”. In the qualitative approach the reality is not separated from the individual as it is in the conventional approach. The qualitative approach emphasises conceptions, and the individual interpretation as knowledge source instead of focusing on empirical material. The qualitative approach is considered having its roots in the inductive scientific approach (See *Philosophical perspectives*), whereas the conventional approach has its root in the deductive approach.

The qualitative approach has an impact on the research process. Overall the process becomes more dynamic and flexible in comparison to the conventional research process. Furthermore, the activity of interpretation and analysis becomes more evident when the researcher chooses to adapt a qualitative approach.

2.3.3 The action research approach

Action research is about processes and occurrences that would not happen without the researcher initiating or effecting an action. The action research approach is about following and documenting a real process.²⁶ For example, if we look at the area of systems development, the nature of it will differ essential if you compare the literature about systems development with the reality of systems development projects. There is an evident gap between literature and praxis.

The implementation process is in action research a way of conducting the investigation and is used for both data gathering and evaluation. Therefore, it is important in action research to discuss and describe the actual research process. A

²⁵ Wallén, 73 ff

²⁶ Wallén, 111 ff

reason for choosing action research is the need of following a certain process. The gained knowledge will serve as a base for further discussion and research. It is also sometimes necessary to study a process in realistic situations in order to get an objective result, due to the fact that interviews have a tendency to give false answers as an effect of people not always acting as they say they do.²⁷

According to Braa and Vidgen, the conduct of research in an organizational setting is a major issue for the information system (IS) community.²⁸ According to them, research conducted in an organizational context - in-context research - is an important and distinguishing aspect of the IS discipline, and particularly so given the fast changing landscape of IS deployment (for example, Internet technologies, globalisation, and virtual organization). Action research is, according to Braa and Vidgen, one purified form of such in-context research within the IS research framework.

2.4 Applied research design – two different perspectives

Our applied research had influences from all above described approaches. The applied methodological path can be viewed from two different perspectives.

The first perspective is to view the three studies made as three separate individual studies in the thesis project, all with different research approaches and methods. The second perspective is to view the thesis project as a whole, a *holistic*²⁹ perspective. We will in this section explain both perspectives. We will start with the first perspective – to view the three studies within the thesis as separate - by sequentially describing the studies, beginning with the literature study.

The literature study was, according to us, an explorative study. It was conducted in order to gain knowledge about all variables concerning our problem area. In this study we wanted to get to know and explore as much as possible about systems development and WAP development.

The method approach would have to be defined as inductive due to the fact that we did literature studies (observations) and added the gained information to our knowledge base, where after we placed it in the theoretical framework.

When it comes to chosen research path we consider it to be conventional meaning that we emphasised objectivity in our findings.

The action research study was also, according to us, an explorative study. The purpose in this study was to gain knowledge by performing a action research study within the problem area and thereby get profound knowledge. When it comes to method choice in this study we classify it as inductive in the meaning that we did a reality

²⁷ Wallén, 114 ff

²⁸ Kristin Braa, Richard Vidgen, *Research from observation to intervention*, Chapter 12 in *Planet Internet*, (Lund: Studentlitteratur, 2000) 252 ff

²⁹ holistic: Emphasizing the importance of the whole and the interdependence of its part. (www.dictionary.com)

observation, where we practically developed a WAP application, and let the knowledge gained serve as our newfound hypotheses.

The research approach applied here was the action research approach. We ourselves were involved and performers in the process, our investigation and what we discovered served as data gathering and evaluation, simply the knowledge base. This knowledge base did also function as a platform for the questions asked to the respondents.

The qualitative study, which consisted of qualitative interviews, can be classified as a descriptive study. In this study we tried to set the characteristics of the research object – systems development and WAP development - by asking the respondents questions within this area. The method approach was inductive, meaning we interviewed our respondents and tried to draw conclusions thereafter. The research approach chosen was the qualitative approach. We were interested in the respondents' subjective opinions, their individual conceptions regarding systems development and WAP development.

The applied methodology for the three studies, seen as separated, is summarized in the table below.

	Literature study (Theoretical framework)	Action research study	Qualitative study
Classification of the study:	Explorative	Explorative	Descriptive
Method approach:	Inductive	Inductive	Inductive
Research approach:	Conventional	Action	Qualitative

Table 2-1 Applied methodology

Now, we move on to the holistic perspective - to view the thesis project as a whole, as one study. In order to do this we will have to make it more complex, by including the thesis problem definition and thesis objective in the methodological path.

The thesis as whole can then be seen as *normative study* – where our objective was to develop a wireless application development model aimed at serving as a normative model for developing quality wireless applications. The method approach would then be inductive in the meaning that three studies would have to be seen as three reality observations from which a general theory or model was formulated, in this case – a wireless application development model. Note that the knowledge base grew for every study made in the thesis. After the three studies were conducted a generalization was made on the basis of the gained knowledge base, which lastly resulted in our conclusion – the wireless application development model.

This approach, the thesis as a normative study, is visualized in the figure below.

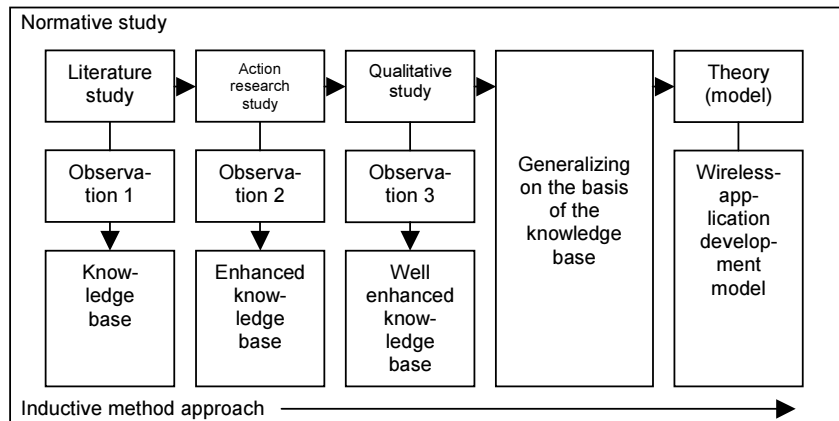


Figure 2-3 The thesis project viewed as a normative study with an inductive method approach

For every study made the knowledge base gradually grows. After the three studies have been conducted a generalization is made which results in our conclusion – the Wireless application development model.

2.5 Data gathering

The different types of data can be divided into two main areas, namely quantitative and qualitative. When it comes to data collection two methods exist: primary and secondary data collection.³⁰ Below follows a brief explanation of the different types and the characteristics of each one of them followed by data and data collection method.

2.5.1 Qualitative and quantitative data

Qualitative data focuses on in-depth information based on data not easily measured such as attitudes, values and perceptions. The aim of the qualitative technique is to study several variables in a small group of respondents.

Quantitative data on the other hand, is more easily collected. Using a quantitative technique variables are studied in a large group of respondents.

The most important difference between the two types of data is that when using a quantitative method the researcher has to be objective and use standardized questions to be able to compare the results. When using a qualitative technique the researcher is supposed to be more flexible and adjust the questions in order to receive a deeper understanding.³¹

³⁰ Eriksson, Wiedersheim-Paul, 65 ff

³¹ Per Darmer, Per V. Freytag, *Företagsekonomisk undersökningsmetodik*, (Lund: Studentlitteratur 1995)

2.5.2 Primary and secondary data³²

An important issue to be decided upon is from where the sample of information is to be selected. Information can be either secondary or primary.

Primary data is information collected for the first time to answer a specific question and is collected by the investigators themselves. Instruments used to gather the information can be surveys, observations or controlled experiments. Primary data can be considered very reliable but pretty expensive in cost and time.

Secondary data is information already gathered and published for a certain purpose. The disadvantage with secondary data is that the reliability can be obscure, because the researcher does not know for what purpose the data was originally gathered. The main advantage of secondary data is that it is relatively cheap and easily accessible.

2.5.3 Qualitative interviews

An elementary method to find out peoples' values and experiences is simply to ask them. There is no way of "measuring" this. Individual, unstandardized interviews are called qualitative interviews. These kinds of interviews have to be performed as a natural dialogue. The caller (the investigator) has to act as a real person not as objective experts in their relation to the respondent. The phenomenology has a strong impact on qualitative interviews focusing on the investigators task to interpret the respondent (See *Philosophical perspectives*).³³

2.6 Applied data gathering methods

The thesis project has used different data gathering methods in its different phases.

Before kicking off the studies we analysed in-depth in what order the studies should be. Having the literature study first was of course a very natural and undisputed decision. A harder task was to decide which one of the action research and the qualitative study should come first. However, we agreed on having the action research study before the qualitative study in order to get a "fresh", self-experienced first acquaintance with the field of WAP application development without being influenced and effected by the opinions of the experts. Nevertheless, we found additional synergies in having this order due to the fact that our knowledge base would thus be more extended when meeting the experts - we would be better prepared, more able to ask relevant questions, and consequently get more information out of the interviews.

Later, when conducting the action research study, a number of questions arose naturally and thereby became relevant for the coming interviews in the qualitative study. This was rather unplanned, but somehow indicated that this order was probably a natural way of proceeding

³² Eriksson, Wiedersheim-Paul, 65 ff

³³ Wallén, 76 ff

Another way to do it could have been to have the qualitative study before the practical. This order would probably have made us being indirectly influenced by the experts' views about the development process and made us restricted in our development process, which eventually would have had a negative impact on the end result of our study.

Now, let us have a look at the applied data gathering methods.

In the literature study (theoretical framework) we have gathered secondary data consisting of literature from the public library and articles from public press about systems development and WAP application development.

In the action research study we gathered primary data from the development process of a WAP application. The action research study was conducted at *Ericsson Compitex*, a sub division within the Swedish telecom company *Ericsson*. From Ericsson Compitex we were assigned to develop a simple WAP application aimed at serving as an alternative interface to an existing web interface for a communication tool product. (For more technical details see Appendix: 8.3 *Action research study: Description of GSM Pro.*) Our action research study, the development process, was supervised by Ericsson staff, which also supported us with guidance and material support.

In the qualitative study we gathered primary data from our respondents in qualitative interviews. The questions asked arose as a result of our findings in the previous studies (the literature and action research study). Our aim was to have a broad range of experts as respondents in order to get a reliable and general result.

Eventually, the respondents were:

Didier Chincholle, Interaction Design Senior Specialist at *Usability & Interaction Lab Ericsson Research* in Kista, Sweden. International speaker and expert of WAP usability design.

Bo Dahlbom, Head of the Department of Informatics at the *School of Business and Commercial Law* in Göteborg. One of Sweden's top scientists within the field of mobile informatics and the author of a range of books within informatics and systems development including "*Computers in context*".

Magnus Ewert, WAP expert and consultant at *Calvia Datakonsult* within different types of data- and telecommunication projects. Author of numerous of data communication books including: "*WAP-Ett steg mot framtiden*".

Johan Hjelm, Senior Specialist at *Ericsson Research* in Japan, and Representative in the *W3C Advisory Committee*. International expert of wireless applications and author of a wide range of publications including "*Designing Wireless Information Services*".

Mattias Olofsson, technology consultant at *Accenture*. Expert of the Mobile Internet, with wide experience of WAP projects.

The applied data gathering methods is illustrated in the figure below.

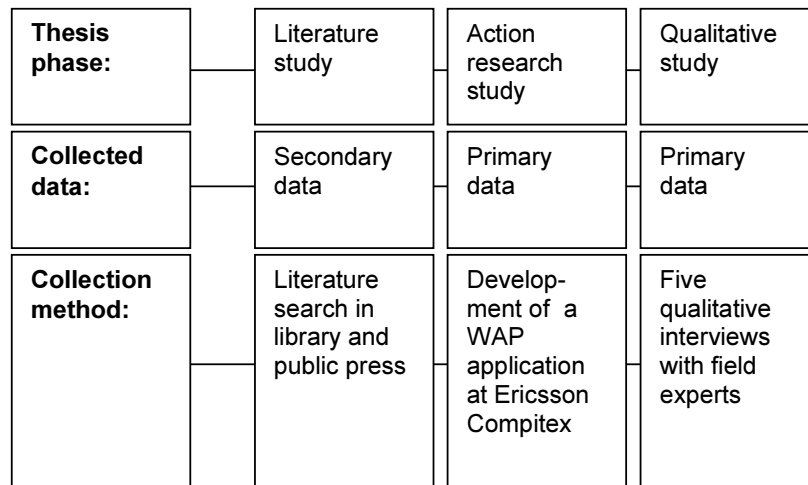


Figure 2-4 Applied data gathering methods in the three thesis’ phases

2.7 Evaluation of the thesis

The aim of all research is to produce results with high degree of quality to convince the reader of the accuracy of the results. There are two major criteria for evaluating the quality of a study: reliability and validity. Many studies fail due to wrong method approach. By analysing the methods chosen you can evaluate how the result has been effected by the applied methodology. This will be done in the following sections: *The validity of the thesis* and *The reliability of the thesis*.

2.7.1 The validity of the thesis

According to Eriksson and Wiedersheim-Paul, validity can be defined as the capability of the measurement instrument to measure what is supposed to measure.³⁴ The authors make a distinction between internal validity and external validity. Internal validity refers to the concepts and the operational definitions of concepts. The internal validity can be examined before gathering empirical data. For example, if an investigation is supposed to measure the number of “unemployed” persons in a society it is important to construct a valid definition of the concept “unemployed” based on empirical criteria of the concept before starting the investigation.

External validity refers to the congruence of measurement between a given operational definition and the reality. To refer to the example above, if one definition of the concept “unemployed” was set and the data was gathered from a false or incomplete register the result would be low “external validity”.³⁵ The external validity is independent of the internal validity and can only be measured after data has been gathered.

³⁴ Eriksson, Wiedersheim-Paul, 38-39

³⁵ Eriksson, Wiedersheim-Paul, 39

In our study we tried to get as high internal validity as possible by studying a lot of relevant literature about systems development and WAP development. We did this in order to get a view as objective as possible on the problem area and to make right definitions of these concepts.

We consider the external validity to be high due to the fact that our thesis is based on two different studies (excluding the literature study), the action research study, which was actually processed in reality by us on the basis of our theoretical framework, and the qualitative study, which was constituted of qualitative interviews with experts on the fields within the problem area.

2.7.2 The reliability of the thesis

The reliability of a measurement explains to what extent the measurement process will give reliable results. Reliability refers to what extent the investigation leads to the same result if repeated. For a study to have high reliability it should be independent of investigators and respondents.³⁶

We believe our thesis to have a high reliability due to the fact that it is based of two studies, excluding the literature study. We believe developing another WAP application by others would have led to pretty much the same conclusions about the development process of WAP applications as the ones we got. The experts participating in our qualitative interviews must be considered as reliable sources, just because of the fact that they are “experts”. The experts’ answers would probably not differ if anyone else conducted the interviews or if other experts within these fields were interviewed.

Further, we aimed at having a broad range of experts in our qualitative interviews, which must be considered as “spreading the risks” in the expected output of the respondent result.

³⁶ Eriksson, Wiedersheim-Paul, 39 ff

3 Theoretical framework

This chapter deals with the theoretical framework of our thesis. The first part of the chapter is about the fundamentals of systems development while the second part is about the specific context that systems development is applied on in this thesis – the Mobile Internet.

The aim of the chapter is to give the reader an insight into the problem area and to describe underlying theories to the thesis.

3.1 Systems development: Definitions of the discipline

In literature, definitions of the discipline systems³⁷ development are unambiguous.

Dahlbom favours this definition³⁸:

Systems development is the discipline doing research on the human (administrative) use of computer technology with the ambition to evaluate and contribute to further development of that technology use.

Dahlbom argues in favour of trying on different perspectives, of countering a management perspective with a user perspective, a producer perspective with a consumer perspective, thus arguing against restrictions that ties the discipline to perspectives such as “use of computer technology”.

In the book *Computers in context*, Dahlbom (et al.) has a more philosophical approach to systems development and means that the aim of typical systems development projects is to support or replace a human activity and that the fundamental idea of systems development is to use technology to make the world a better place for humans.³⁹

Flensburg explains that systems development has to do with administration, information processing and computers⁴⁰. He defines the systems development like this:

Systems development normally means how computers can be used in order to make the administrative activities in an organization more efficient.

Goldkuhl has another definition of systems development⁴¹: He expresses systems development as:

³⁷ System: A group of interacting, interrelated, or interdependent elements forming a complex whole.(www.dictionary.com)

³⁸ Bo Dahlbom, *Systems Development as a Research Discipline*, (Göteborg: Chalmers University of Technology Department of Computing Science, 1994), 9 ff

³⁹ Bo Dahlbom, Lars Mathiassen, *Computers in context*, (Oxford: Blackwell Publishers Inc, 1999), 27, 135

⁴⁰ Per Flensburg, *Systemutveckling med människan i centrum*, (Lund: Studentlitteratur, 1987), 95

People's work with analysing, designing, and changing enterprises where computer systems are involved or planned to be involved.

According to Goldkuhl, systems development must not be viewed as isolated, but as an integrated activity within the enterprise.

Andersen makes a distinction between systems development and systems work. He argues that system development involves systems work, realisation, and implementation. According to Andersen systems work is a part of the systems development process. Systems work includes the following activities: organizational analysis, information system analysis, principle design of technical solution, design of material customized technical solution.⁴²

3.2 Concepts within systems development⁴³

Within systems development there are certain concepts that have to be cleared out.

Andersen summarizes them being *models, methods, techniques (especially description technique)*, and *tools*. In our thesis only the first two concepts, model and method, are relevant.

A model is an overview of the development process. It describes the accumulated work that has to be done, and who should do it. A model is sometimes referred to as a framework. A model consists of certain phases, stages, and problem areas.

A method is a detailed description of how a specific problem should be solved. A method is far more detailed than a model. A method is characterized by the area on which it should be applied, i.e. on which problems the method can be applied. A method should also contain the applied activity, and how this activity should be organized. Lastly, a method should also include the applied description techniques and how they should be applied. A method is a way of solving a problem. It is important to be aware of on what problems the method can be applied, and on what problems it can not be applied.

A technique is a way of working, a workflow process. Within systems development there are several techniques. Programming technique is one. It describes the way of working when programming. Within system development *description techniques* are the most interesting. A description technique is a kind of a recipe of how to conduct a description. This recipe consists of a number of rules, which tell us how the reality/the enterprise can be formulated in a description.

A tool is a physical aid. A physical aid can in systems development be software designed to support the development process (e.g. CASE⁴⁴).

⁴¹ Göran Goldkuhl, *Verksamhetsutveckla datasystem* (Linköping: Intention, 1995), 25

⁴² Andersen, 42 ff

⁴³ Andersen, 99 ff

⁴⁴ CASE = Computer Aided Software Engineering

3.3 Systems development models

Models come and go. Especially within dynamic disciplines as computer science and systems development, new theories and models are imposed on a regular basis. Therefore it is difficult to present static system development models. There is no such thing as “one right model” - only different alternatives. We have tried though to outline some models that according to us have to be considered as general models, or at least models serving as good examples in the systems development discipline. We begin with a description of traditional models in general, followed by describing Andersen’s model more in detail, and lastly we explain software development models.

3.3.1 General systems development models

One idea that has been around since 1970 is to describe the steps taken by developing an information system as a recognizable pattern. Brown describes these steps in a *Systems Development Life Cycle (SDLC)*⁴⁵. The SDLC can be divided into smaller steps, according to Brown, but the general steps are the following:

Analysis: The users’ business and problems are studied in order to discover *what* the users need the system to *do*. *How* it should be done is *not* considered.

Design: Production of a plan or design is done, showing *how* the system will do the functions identified in the analysis phase. Hardware- and software platform are considered, choice of language, operating system, and database software. Design of databases, programs, screens and report are done.

Construction: The programs are written and the databases are built. The whole system is tested and debugged.

Implementation: The system is installed in production, and the users are trained.

Maintenance: Corrections are made. Bugs and program errors are fixed. Improvements are made.

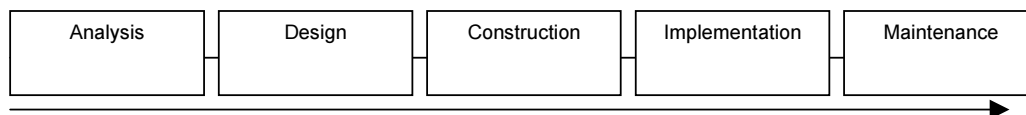


Figure 3-1 The SDLC and its main phases⁴⁶

According to Stevens (et al.) the life cycle shows a sequential development approach, from the user requirements to the delivery of the complete operational capability.⁴⁷ This model consists of a sequence of processes from user requirements, through systems requirements, architectural design, and component development to the testing cycle of integration, installation and operations. At each process boundary, a review

⁴⁵ David Brown, *Object oriented analysis – objects in plain English*, (USA: John Wiley & Sons, Inc, 1997), 37

⁴⁶ Brown, 37

⁴⁷ Richard Stevens, (et. al), *Systems engineering – coping with complexity*, (Wiltshire: Prentice Hall) 1998), 7 ff

or a test allows progress to be monitored and a commitment made to the next stage. These boundaries act as quality milestones, according to Stevens (et al.). The life cycle defines the order in which information must be produced, and the users, developers, and designers each have responsibility for separate parts of the information. The life cycle, according to Stevens, (et al.) is presented below.

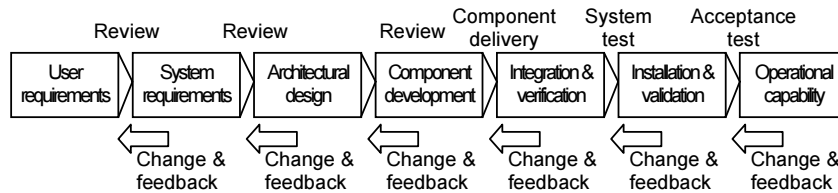


Figure 3-2 The simple systems life cycle, according to Stevens (et al.)

According to Goldkuhl, the systems development process can be divided into three main phases⁴⁸:

- Organization- and information need analysis
- Computer system⁴⁹ realization
- Implementation

Organization- and information need analysis, (OINA) (translated by us from the Swedish concept: Verksamhets- & informationsbehovsanalys (VIBA)), means an analysis of the organizational activities and the data system from an organizational point-of-view. The actions of the computer system (data processing and communication) and information based on the organizational information needs, are described and analysed. OINA leads to a detailed requirement specification.

With the requirement specification at hand the computer system can be realized in two different ways:

- development of proper system (own development)
- acquire a standard system (from external developer)

Development of proper system often includes working with:

- Database design
- Program/module division
- Program construction and coding
- Program testing

Acquirement of a standard system involves evaluation, choice and adjustment of such a system.

⁴⁸ Goldkuhl, 25

⁴⁹ We refer to Goldkuhl's definition of a computer system : *A computer system means computerized processing and management of information.* (Göran Goldkuhl, *Verksamhetsutveckla datasystem* (Linköping: Intention, 1995), 12)

After system realization has been done, an implementation phase may involve the following activities:

- System test
- Design of manuals
- Education
- Organizational coordination
- Kick off

When the systems have been implemented in the organisation, support and usage is followed. Continuous development, maintenance, and support is performed parallel to the usage of the system.

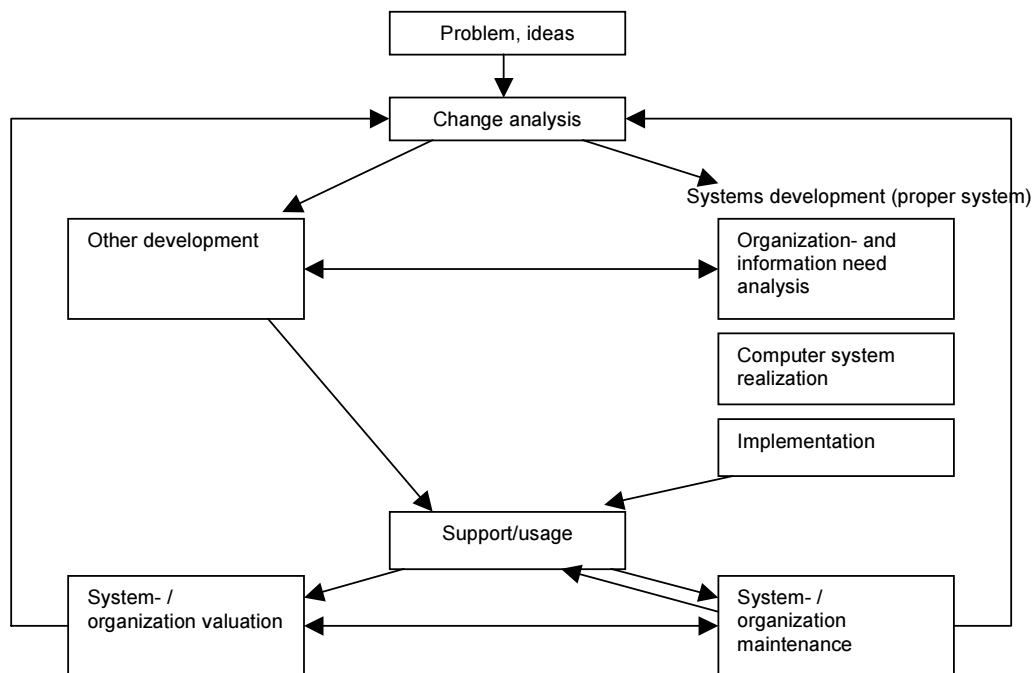


Figure 3-3 The systems development process according to Goldkuhl

3.3.2 Andersen's model

Andersen exemplifies the development process of a information system in *the life cycle mode*.⁵⁰ He argues that the development process of an information system has to be viewed in a broad perspective, which means initiating the process by discussing the current problems and opportunities the enterprise is confronting. Such a discussion will eventually lead to a number of measures taken. Andersen explains that before getting on with the development of the actual information system, questions regarding “what is desired to be achieved “ must be raised before starting a discussion of possible technical solutions. The choice of technical solution is important, Andersen stresses, but should never be discussed before the real purpose of the information system is stated.

Andersen argues further that the major part of the development process has to do with descriptions of various sorts (Read about descriptions in *Concepts within systems development*). A system grows from different descriptions, starting with overall descriptions about the desired output of the information system to the eventual detailed technical descriptions. The development process must, according to Andersen, be based on distribution of labour and utilization of experts.

The life cycle model has, in brief, the following structure:

The first problem area (0) is the change analysis. Discussions are held on topics like: What needs to be changed and improved in the enterprise?; What opportunities and threats are emerging in the enterprise?, i.e. organisational issues and general corporate matters.

Problem area 1 and 2 is a co-term for the analysis phase. It is the “what-oriented” area of the systems work, i.e. where “what the system will do” is decided upon.

Problem area 3 and 4 is the design phase. It is the “how-oriented” area of the systems work.

In-between the analysis phase and the design phase comes the requirement specification. Yet, the design phase has two parts. In the first part the general technical solution is set. Afterwards, in part two of the design phase, the applied technical solution is adjusted to material prerequisites (e.g. software and hardware) within the enterprise.

Problem area 5 is the realization, which involves the actual construction of the system, i.e. programming procedures.

Problem area 6 is the implementation of the information system, which means kicking off the system.

Having completed the problem area 6, the development process is considered over. The system is integrated in the enterprise.

⁵⁰ Andersen, 39 ff

Problem area 7 is called maintenance and is supposed to include support of the daily use of the system. Parallel a continuous process of quality control should be going on, which might lead to improvements and changes in the system. This activity is included in the problem area 7.

Problem area 8 is the phase out of the system.

Andersen's model is visualized in the table below.

Problem area	0	Systems Development							
		System work process				Realisation	Implementation	Main-maintenance and support	Phase out
		Analysis		Design					
1	2	3	4	5	6	7	8		
Problem	The threats and opportunities within the enterprise	IS support in the enterprise	The content of the IS	Choice of principle technical solution	Design of technical solution based on the existing solution.	Prepare the IS	Kick off	Maintain the system and make improvements	Phase out the system
Tasks	Describe the current situation Describe the desired situation Describe needed changes Describe alternative measures Describe further process	Analyse the enterprise and determine how the IS can facilitate the activity within the enterprise	Evaluate and determine the content in the IS	Evaluate and determine principle technical solution	Choose adequate equipment Evaluate and determine a practical solution.	Prepare applications and new routines	Implementation of new applications and new routines	Do corrections Evaluate needs, and occasionally implement improvements Support	Secure information
Basic data	Problem list Wish list List of needed changes List of possible progress alternatives	Descriptions showing coherence between the IS and the enterprise activity	Descriptions of the IS, i.e. input process, maintenance, and the retrieving process (output)	Principle descriptions of technical solution	Detailed description of technical solution	Detailed description of technical solution	User manuals from the developers and programmers	Experience material from the users Service instruction	Descriptions of data and databases
Participants in the discussion	Management Employees Consultants	(User) Staff, (User) Management (User) Representatives for the Employees Systems developers	Users and System developers	System developers Programmers	System developers Programmers	Programmers (Users)	Users System developers Programmers	Users Programmers System developers Users Support personnel	Person responsible for the system System developers Users Support personnel

Figure 3-4 Systems development and its current and followed problem areas, according to Andersen.

Erling S Andersen, *Systemutveckling – principer, metoder och tekniker* (Lund: Studentlitteratur, 1994) 41

3.3.3 Software development models

According to Stevens (et al.) software has become the soul of systems, often controlling the interactions between sub-systems.⁵¹ Stevens (et al.) argues that where the same information is required across many different sub-systems the software-based data management system coordinates the whole task. Software development projects are embedded in systems development. Therefore, it is essential to examine software development models. Software development in the context of systems development is illustrated in the figure below.

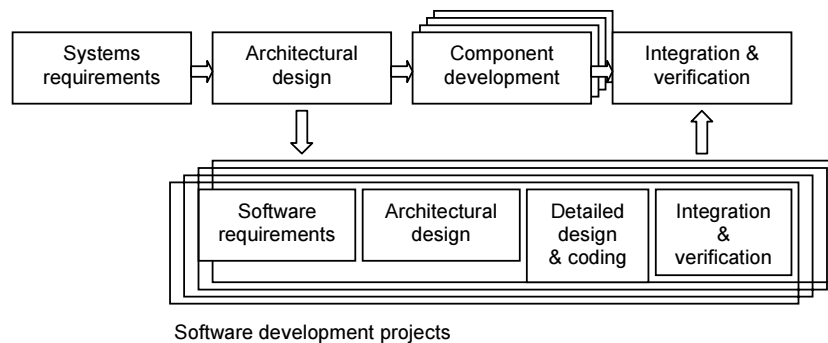


Figure 3-5 Embedded software within a system, according to Stevens (et al.)

In literature about software engineering *the waterfall model* often comes across. The waterfall model, is according to Lewis and Loftus, however an unrealistic approach to development due to the fact that the model does not take into account that the stages within the development process in reality are overlapping, and not so clear cut as the model suggests.⁵²

Basically the model has four main stages in order to produce a system: *establish requirements, create design, implement code* and *test system*. The waterfall model is linear, with one stage followed directly by the next. The model comes from the implication that information is flowing in one direction from one stage to the next until the final release is created.

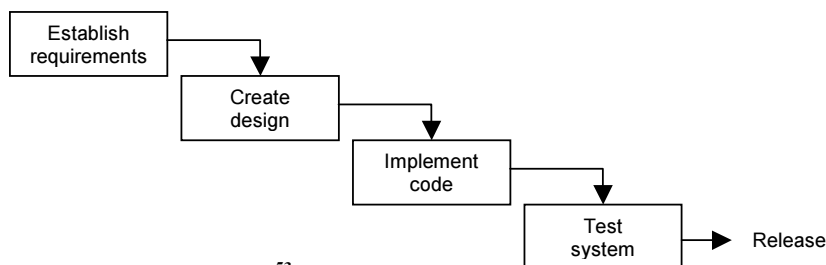


Figure 3-6 The waterfall model.⁵³

⁵¹ Stevens, (et. al), 230 ff

⁵² John Lewis, William Loftus, *Java software solutions: foundations of program design*, (USA: Addison Wesley, Longman, Inc, 1998), 408 ff

⁵³ Lewis, Loftus, 412

A more realistic development model approach would according to Lewis (et al.) be an iterative process where the development activities would be revisited, thus allowing proper changes to be made when needed. Such a model would be the waterfall model having backtracking.

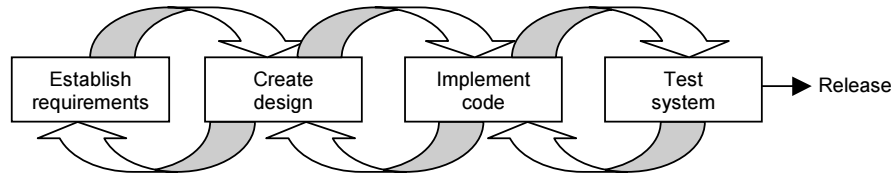


Figure 3-7 The iterative development process.⁵⁴

⁵⁴ Lewis, Loftus, 413

3.4 Mobile Internet

3.4.1 Mobile Internet - The Internet through mobile phones

The Mobile Internet, what is it?

Very simplified, the Mobile Internet is wireless Internet access through a mobile phone.⁵⁵ It is important, though, to be aware of that the mobile phone has to have special features (e.g. a WAP browser) in order to access the Internet. And additionally, the web sites (documents) accessible must be especially designed for mobile phones (for access through a WAP phone, the web documents must be written in WML⁵⁶). It is not possible to read normal web documents, i.e. pure HTML⁵⁷ documents in a mobile phone, even when the phone does have browser capabilities (e.g. WAP phone).⁵⁸

So basically, exploring the Mobile Internet is the same thing as exploring the “real” Internet through a special mobile phone (e.g. phone). But, with the parenthesis that the accessible documents on the Internet must be especially designed for mobile phones. Accordingly, the Internet and the mobile phones are the main ingredients for this sort of wireless communication.

Hjelm explains the evolution of these two ingredients, as follows:

*The wave that we are just about to enter merges two technologies that have experienced a steep growth over the last few years, affected the lives of millions, and reshaped the global economy – the Internet and the mobile phone.*⁵⁹

Hjelm claims that there has been a steep growth in two areas during the last decade - the Internet and mobile phone usage.

The Internet has completely revolutionized the world of computers and communications, like nothing else before. Described as a world-wide broadcasting capability, the Internet is likewise a mechanism for information dissemination, and a medium for collaboration and interaction between individuals and their computers, regardless of geographic location.⁶⁰

⁵⁵ *Mobile Internet Kit*, www.palm.com

⁵⁶ WML= Wirelss Markup Language. The language used for creating documents to be read by mobile phones.

⁵⁷ HTML= Hyper Text Markup Lnguage. The language used for creating “normal” web documents to be read by computers.

⁵⁸ “Unless a website is written in WML, a WAP phone can't access it. And there are only 24,000 WAP-accessible sites in the world, according to wireless resource Pinpoint.com.”

Source : Elisa Batista, *WAP or I-Mode: Which Is Better?*, www.wired.com

⁵⁹ Johan Hjelm, *Designing wireless information services*, (USA: John Wiley & Sons, Inc., 2000), 19

⁶⁰ Internet Society, *A Brief History of the Internet*, (www.isoc.org)

The Internet was the result of some visionary thinking, done by people in the early 1960s. These people saw great potential in allowing computers sharing information on research and development in scientific-and military fields. In 1989 a significant event took place in making the nets easier to use. Tim Berners-Lee (sometimes referred to as the “founder” of the Internet) and his colleagues at the European Laboratory for Particle Physics, better known as CERN⁶¹, proposed a new protocol for information distribution. This protocol became known as the World Wide Web in 1991.⁶² Since then, Internet usage has exploded. According to the Computer Industry Almanac Inc., there were over 400 million Internet users worldwide at year-end 2000, up from less than 200 million Internet users at year-end 1998.⁶³ In 1999 there were more than 10 million sites in the world on the Internet, and in 2005 it is expected to be more than 200 million sites and 50 single billion web pages on the Internet.⁶⁴

The evolvement of mobile phone usage has also been truly astounding. At the end of 1999, there were more than 450 million subscribers around the world, rising from just 11 million in 1990.⁶⁵ This is a compound annual growth rate of more than 50 per cent per year. In other words, the number of mobile subscribers worldwide has doubled every 20 months since the beginning of the decade according to an investigation by ITU (International Telecommunication Union).

Naturally, the increased usage of the mobile phones and the remarkable growth of the Internet have created a widespread wish to access Internet information and services also by the mobile phone. Techniques like *WAP* in the western world, and *I-mode* in Japan have made this wish come true. Still today, at least in the Western Europe, available services and accessible information for mobile phones are quite few. The Mobile Internet has not yet boomed. This mainly because it still suffers from certain constraints, like hardware delimitations, making usage rather inconvenient and difficult.

3.4.2 Mobility

The society of today has become more and more influenced by the notion - information technology (IT). IT as a concept is often referred to as collecting, processing, storing and sharing information, with computers, software, and telecom equipment as the distributing communication tools. New information techniques have made it possible for people to become more mobile, both off and at work. People are no longer tied to specific geographic places. And as the pace of work speeds up, and the rate of life as a whole becomes more strained, mobility becomes more and more desired and necessary.

Mobility⁶⁶ is a frequent used word in this context, but what exactly is mobility?

⁶¹ CERN = European Organization for Nuclear Research

⁶² Delphi, *A Brief History of the Internet*, (www.delphi.com), (2001)

⁶³ Computer Industry Almanac, *U.S. has 33% Share of Internet Users Worldwide Year-end 2000 According to the Computer Industry Almanac*, (www.c-i-a.com)

⁶⁴ Jakob Nielsen, *Designing web usability - the practise of simplicity*, (USA: New Riders Publishing, 2000), 346

⁶⁵ International Telecommunication Union, *The mobile cellular boom*, (www.itu.int)

⁶⁶ Mobility = The quality or state of being mobile. (www.dictionary.com)

Kristoffersen and Ljungberg have made an effort to define mobility in the context of IT.⁶⁷ One main objective for their work was to reflect on how the IT use in mobile settings distinguishes from the IT use in more traditional surroundings.

Environment, modality and applications are according to Kristoffersson and Ljungberg the three main fundamentals of mobile IT use.

- *Environment* is the physical and social surrounding.
- *Modality* is the fundamental pattern of motion, such as:
 - Travelling, the process of going from one place to another.
 - Visiting, spending time in one place for a temporal period of time before moving on to another.
 - Wandering, extensive local mobility in a building or local area.
- *Applications* is the combination of technology, program and data to use.

Mobility in the context of IT is a concept dependent on all of the above mentioned factors and therefore quite hard to define. Every single human being has its own unique and presumably clear perception of what mobility means and involves for her. Some might say that mobility means freedom, others might argue that it means never being able to be off-line. Consequently, the definition of mobility must be regarded as something very subjective, and nothing that can be, or at least is very hard to be generalized upon.

Below Dahlbom and Ljungberg explain the evolution of mobility as a consequence of the massive impact of information technology on today's society:⁶⁸

There is a shift from bureaucratic document management to the bustle of the market with its many meetings. The old factories for office work, education, research, and health care disintegrate and are replaced by meeting places for mobile service exchange. Today's project and team-based organizations are designed to promote cooperation. Cooperation leads to increased use of IT that bridges distance, such as email, but it also leads to mobility: people travel to meet physically.

Technical solutions and the possibilities they bring thus become very important for this new mobile environment and its participants. There is no doubt that the mobile phones, and to some extent other handheld devices have become a very important part of peoples life and are some of the most indispensable products in daily life. For organizations, like those Dahlbom and Ljungberg refer to, the mobile device itself has become an almost invaluable tool in daily business life.

Dahlbom and Ljungberg claim that mobile computing is growing rapidly, but still, has a long way to go. Other experts use terms like "clumsy" and "restricted" when to express the format and content of mobile computing.⁶⁹

⁶⁷ Viktoria Institute, Gothenburg, Sweden and Norwegian Computing Centre, Oslo, Norway, *Mobile Use of IT*, Kristoffersen, S., Ljungberg, F., (www.viktoria.se), (1999)

⁶⁸ Viktoria Institute and Department of Informatics, Göteborg University, Sweden, *Mobile Informatics*, Dahlbom, B., Ljungberg, F., (www.viktoria.se), (2000)

⁶⁹ Financial Times, *The next internet boom*, Peter Martin, (www.ft.com)

In order to express their own attitudes towards devices associated with mobile computing, Dahlbom and Ljungberg mean:

*Mobile phones, personal digital assistants (PDAs), mobile information appliances, and wearable computers are developed and marketed, but their functionality is still rudimentary except for making telephone calls, playing games, and managing time.*⁷⁰

As mentioned above the mobile devices are to a large extent responsible for the limitations with today's inconvenient Mobile Internet usage. These delimitations are further explained in the section *WAP from a user's perspective*.

Let's now have a brief look at a technique, enabling access to wireless services and the Mobile Internet – WAP.

3.5 WAP

The premier use of mobile phones is to be able to contact people for voice communication, but the possibility to bring other more sophisticated services to the phone or to some other mobile device, do exist. One of these services goes under the designation WAP.

WAP is an enabling software application that allows special web pages to be relayed to certain mobile phones and other devices that are compatible to the standard. In its present form it is suitable for presentation of small amounts of information that are transported relative fast over the net.

From a more technical view, WAP does for wireless devices what HTTP (Hyper Text Transfer Protocol) does for web browsers. HTTP is the protocol that the Web uses for data transport; it allows the browser to be client in an Internet based client/server model. In many ways WAP is similar to HTTP. Like HTTP, WAP is as a collection of protocols (data transport mechanisms) and standards that along with special mark-up and scripting languages together define a complete solution.

3.5.1 Background

WAP stands for *Wireless Application Protocol*, the de facto standard for wireless computing of today, managed by a consortium of vendors called the *WAP Forum*.

Before the creation of the WAP Forum in 1997, all of the telecommunication giants were developing their own protocols and mark-up languages for wireless Internet access. Nokia had Narrow Band Sockets (NBS) and the Tagged Text Markup Language (TTML), Ericsson had the Intelligent Terminal Transfer Protocol (ITTP) and Phone.com had the Handheld Device Markup Language (HDML). This diversity threatened to fragment the wireless data access market. Therefore, Ericsson,

⁷⁰ Viktoria Institute and Department of Informatics, Göteborg University, Sweden, Dahlbom, B., Ljungberg, F., *Mobile Informatics*, (www.viktoria.se), (2000)

Motorola, Nokia and Phone.com all agreed that it was best for creating a forum to discuss wireless Internet data access standards. Hence, the WAP Forum was created.⁷¹

*The WAP Forum Ltd. is now an industry association with hundreds of members that continuously develops and promotes the de facto world standard for wireless information and telephone services on wireless devices. The charter of the WAP Forum is to bring together service providers, device and infrastructure manufactures, Internet content providers and application developers in order to ensure interoperability and growth of wireless Internet-based services.*⁷²

3.5.2 From a user's perspective

The client in the WAP model today is usually the mobile phone (e.g. WAP compatible mobile phone). But there are alternatives of wireless devices, like PDAs. All these devices have in general two common characteristics:⁷³

- An integrated browser, called a micro browser.
- A mechanism for user input, which can range from a couple of buttons on simple models to entire banks of buttons with roll bars and touch screens on higher-end models.

With mobile devices being different, in terms of models and brands, the devices' respective capabilities and features differ as well. Even though WAP is designed to be device independent - this is not the case in practise (the code you write for one device should in theory work on all possible devices as long as they have WAP compatibility). When it comes to functionality and usability for WAP applications, there is unfortunately a major difference between "running" and "running as intended". Different devices implement different features in different ways, and the displayed result, thus, differs from device to device.⁷⁴ In fact, this is one of the WAP developer's major problems - building interfaces interpreted by several devices in exactly the same way.

Furthermore, compared to desktop computers, wireless devices present a much more constrained computing environment. General fundamental limitations of handheld devices in comparison to desktop computers are:⁷⁵

- Less powerful CPUs
- Less memory
- Restricted power consumption
- Smaller displays
- Different input devices

⁷¹ Zdnet, *Supporting the Wireless Application Protocol (WAP) in Linux*, Boris Kuschel, (www.zdnet.com), (000912)

⁷² WAP Forum, *WAPForumBrochure*, www.wapforum.org

⁷³ Forta et al., *WAP Development with WML and WML-script*, (USA: Sams Publishing, 2000), 13

⁷⁴ Forta et al., 13

⁷⁵ WAP Forum, *WAP white paper*, www.wapforum.org

So still, there are many shortcomings with today's mobile devices making them function as clients in the WAP model. Several of the above mentioned limitations will though, undoubtedly, become less and less significant the more the technical development advances. Better, faster, and cheaper technologies are constantly under development (Moore's law⁷⁶) thus making way for fundamental improvement, also in the field of mobile computing.

The most important and appreciated pretension for the user, however, is probably the size of the mobile device. But the size quality is a trade-off to the device's browsing quality (the smaller the device is, the smaller is the display and the less suitable is it for browsing). This means that today's manufactures have to, either compromise between these two properties, or simply choose quality for only one of them.

Among experts, the standard of mobile devices and its browsing capabilities today is often compared to what the WWW (World Wide Web) and its presentation conditions, and content spectrum were in the early 90s.⁷⁷ Back then, the process of using the plain text browser *Lynx* to surf at the World Wide Web was not considered very exciting, and the same level of excitement is what many mobile internet users experience today.

3.5.3 WAP Usage

ITU forecasts that by the middle of this decade, there will be more cellular subscribers worldwide than there will be fixed-line subscribers.⁷⁸ This incredible growth rate plus the fact that many of the mobile devices on the market today do have WAP functionality, means that a large number of mobile users today have the opportunity to access WAP services. The market analyst *Datamonitor* estimates that today, only in Europe, there are 16.5 million WAP subscribers.⁷⁹

As a parenthesis, I-mode, the third generation (3G) mobile technique in Japan, has at the moment over 22 million users, and still adding 1,5 million new users per month.⁸⁰ This substantial development is today reality, despite the massive criticisms in press in the beginning of 1999.⁸¹

3.5.4 In comparison to web usage

The major hardware differences between the client side on the Web and the client side on the Mobile Internet were discussed in detail in *WAP from a user's perspective*.

For web publishing, web developers can not be sure to provide a complete single representation of their information due to the fact that the clients have different types of prerequisite, like: browsers, operating systems, etc. This phenomenon is even more obvious in the WAP environment, where there is a large amount of different clients

⁷⁶ Moore's law states that semiconductor power doubles every 18 months.

⁷⁷ Financial Times, *The next internet boom*, Peter Martin, (www.ft.com)

⁷⁸ International Telecommunication Union, *The mobile cellular boom*, (www.itu.int)

⁷⁹ Wired News, *WAP or I-Mode: Which Is Better?*, Elisa Batista, (www.wired.com)

⁸⁰ Web techniques, *Waiting on WAP*, Ray Valdés, (www.webtechniques.com)

⁸¹ Joakim Båge, "Japaner först med 3G nät", *Dagens Industri*, (010404)

with many different browser- and hardware settings. In addition, it should be mentioned that the gateway, functioning as an intermediate between the client and the content server in the WAP-model interprets code differently depending on brand and version. Consequently, content presentation is dependant on gateway interpretation as well.

Hjelm explains:

*In the mobile environment, designers are forced to design the information, not a graphic presentation.*⁸²

Graphical design is reducibly supported in WAP. In contrast, many popular web sites on the Web today are popular, not only because of the content, but because of the design – it is a graphical experience to enter some sites!

Logotypes and other distinguishing graphical features make you recognize sites and thus somehow enhance value to web sites. WAP however, *can* present simple pictures, but do not at all have those advanced prerequisites for graphical presentation as the ones the Web has.

Traditional use of Internet via a personal computer (PC) can today still be considered the far best way to exchange information. The PC screen is big, the keypad, with its big buttons, is not so limited as the ones on mobile devices. Due to the PC's superior advantages in browsing and use convey, in these aspects the mobile device today has no chance of competing, and therefore often comes out as a pretty weak alternative for those kinds of purposes.

However, in terms of mobility the use of a mobile device and wireless communication is preferable. For simple and compact information retrieving (e.g. email- and train schedule check) in situations requiring mobility (travelling, wandering, and visiting) the usage of Mobile Internet is a strong candidate in comparison to traditional Internet usage, which in turn requires more stationary equipment.

3.5.5 Typical wireless applications

From a technical point-of-view, there are no restraints in enabling traditional web services becoming wireless. As demonstrated in Appendix 8.2: *Mobile Internet: More about WAP*, the architectural platforms of the Internet model and the Mobile Internet model (i.e. WWW and WAP) look quite the same, except for some intermediates added in the wireless model. So theoretically, all services you could find on the Internet, for example, banking, shopping (e-commerce), e-mail (messaging) and information searching (portals and infotainment) and so forth, should be possible to realize in a wireless format. However, this generalization does not take fundamental aspects as hardware delimitations into account. With those considered, the number of services, sadly enough, becomes fairly reduced with today's technological prerequisites.

So what can we expect as wireless applications?

⁸² Hjelm, 39

Well today, the dominating wireless applications on the Mobile Internet are infotainment. "News" can be accessed on the Mobile Internet.⁸³ Traditional web portals have also slowly started to publish information for mobile users.⁸⁴ Some wireless online banking services can also be found, although they are quite unusual.⁸⁵ E-mail can also be managed through a mobile phone today and can therefore be regarded as a wireless service.

According to experts, we can in the future, in the same pace as technology makes progress, expect services like positioning services, m-commerce services and an explosion of infotainment. But today with barely 8 million WML pages and 25.000 WAP sites, the market supply is rather limited.⁸⁶

⁸³ Computer Sweden, *SVT satstar på mobila nyheter*, (www.computersweden.se), (010222)

⁸⁴ Spray, (www.spray.se - wap.spray.se)

⁸⁵ Computer Sweden, *Trådlösa tjänster hot mot banker*, (www.computersweden.se), (001109)

⁸⁶ Wired News, *Combating WAP's Bad Rap*, (www.wired.com), (010319)

4 The Studies

4.1 The action research study: Development of a wapp

4.1.1 Background

The process for us developing a WAP-application was done at Ericsson Compitex in Mölndal, Sweden between November 2000 and March 2001.

We were assigned a task to develop a WAP prototype for a communication tool product called GSM Pro. In brief, GSM Pro consists of a server-node in the network that facilitates the services, a dispatch console for the work-group management, and a phone tailored to meet the needs of field-working professionals or other groups with desires of a durable hand-set. GSM Pro provides capabilities such as group calls, alert calls, and status messages - functions that are common in PMR systems (Professional Mobile Radio). All management and administration of GSM Pro features was before our work performed through a web interface. In order to add extra features to GSM Pro, Ericsson Compitex wanted to have WAP-interface capabilities for complementary administration.

The suggested requirement specification for the prototype included three functions, already existing in the web interface, in a new WAP application. The functions were: add member, delete member, and list members. We were free to decide how we wanted to develop the application, what development models to use, what programming techniques, what programming languages, etc.

As informatics students we treated this assignment as a small-scaled systems development project, with Ericsson Compitex as the client, the three-function-WAP-prototype as the information system to be built, and us as the systems developers. Accordingly, the action research study had all main fundamentals characterizing a real systems development project, but of course of a much smaller size.

In our study we mainly used Andersen's systems development model as a framework for the work process (See *Theoretical framework*), and tried to follow it into the extent it was possible. However, the development process for us did not focus on the organizational aspects of systems development, i.e. the initiative for the client (Ericsson Compitex) to construct a WAP application was not due to an organizational need or change. Instead, the Ericsson Compitex simply wanted to add extra features to their product. Therefore the project was in many ways also a pure software development project, which is why we used features from software development models in the fundamental framework of our project as well.

4.1.2 Applied systems development model

The model we applied in our development process was a combination of Andersen's life cycle model and a traditional systems development model (Stevens's (et al.), Brown's). It had the following main stages: *analysis*, *design*, *realisation*,

implementation & testing. Basically it had the phases classified as systems work in Andersen's model, except for the last stage where we also added "testing", since this is an important part in software development in general and WAP development in particular.

We also decided to use the iterative approach related to software development in our model, since this is natural and necessary in software development. The stages roughly included the following activities:

- Analysis: analysis of the WAP interface in its context.
- Design: design and choice of a technical for possible technical solutions.
- Realization: realization of use case scenarios and programming.
- Implementation & test: implementation and test of the WAP application in various browsers and WAP-phones.

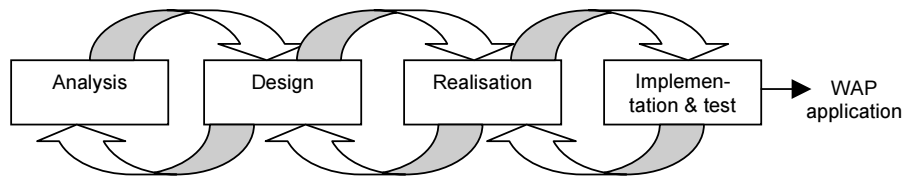


Figure 4-1 A simplified version of the applied systems development model

4.1.3 Specific description of the applied model

In order to add precision, we tried to apply Andersen's model, as a framework when developing our WAP application in the extent it was possible. The objective was to adopt the model on our specific case with corresponding activities in the corresponding stages in the model.

Each stage within Andersen's model was supposed to include certain areas which have to be defined and taken into account before beginning the development process. As a consequence, the different stages in our WAP development process intended to include the following stages. Note, that we use the word "intended", since this was the *plan* before beginning the project, not the exact outcome. The outcome of the study is presented in *The Results*.

In the first stage of analysis, *Analysis of the enterprise*, we were expected to do an analysis of how the GSM Pro WAP interface could add value to the organization. The problem definition in this stage was set to *The function of GSM Pro WAP interface within an organization*. The participants in the discussion were supposed to be GSM Pro Staff, and us, in the role of system developers. Data output was expected to be documents describing the GSM Pro WAP interface and its main features.

In the next stage of analysis, *Analysis of the information system*, we were expected to evaluate and determine the content of the GSM Pro WAP interface. The problem

definition in this stage was set to *The content of the GSM Pro WAP interface*. The participants in the discussion were supposed to be GSM Pro Staff, and us, in the role of system developers. Data output was expected to be documents describing the main features of the GSM Pro WAP interface.

In the first stage of the design phase, *Principle design of a technical solution*, we were expected to evaluate and determine principle technical solutions and do an analysis of different WAP model alternatives. The problem definition was set to *Choice of principle technical solutions to implement a WAP interface to the GSM Pro product*. The participants in the discussion were supposed to be us, in the roles of both system developers and programmers. Data output was expected to be documents describing different WAP model alternatives.

In the second stage of the design phase, *Design of technical solution with physical considerations*, we were supposed to choose adequate equipment, evaluate and determine a practical solution, choose WAP model based on the technical environment within GSM Pro, choose programming language, and choose adequate WAP functions on the basis of the web interface. The problem definition of this stage was set to *Design of technical solution based on the current solution*. Data output was expected to be documents motivating our choice of applied WAP model and applied programming language. Participants in the discussion were supposed to us, in the roles of both system developers and programmers.

In realization, we were expected to carry through: constructing use case scenarios, WML GUI's, programming of back-end ASP code, and WML scripts. The problem definition in this stage was set to *Prepare the IS*. The participants in the discussion were supposed to be us in the role of programmers. The data output expected was a detailed description of the technical solution.

In implementation & test, we were expected to implement the WAP application and do parallel testing. The problem definition in this stage was set to *Kick off*. The participants in the discussion were supposed to be the users (GSM Pro Staff), and us, in the role of system developers and programmers. The data output of this stage was expected to be user manuals.

For overview, the stages in the model are presented in the table below.

E. Andersen's' <i>Systems Development model</i> applied on the development process of the GSM Pro WAP interface						
	System oriented process				Realization	Implementation & Testing
	Analysis		Design			
Problem area	1 Analysis of the enterprise	2 Analysis of the Information System	3 Principle design of a technical solution	4 Design of technical solution with physical considerations	5	6
Problem	The function of GSM Pro WAP interface within an organization	The content of the GSM Pro WAP interface	Choice of principle technical solutions to implement a WAP interface to the GSM Pro product	Design of technical solution based on the current solution	Prepare the IS	Kick off
Tasks	Analysis of how the GSM Pro WAP interface can add value to an organization.	Evaluate and determine the content of the GSM Pro WAP interface	Evaluate and determine principle technical solutions: Analysis of different WAP model alternatives	Choose adequate equipment Evaluate and determine a practical solution: Choice of WAP model based on the technical environment within GSM Pro Choice of programming language Choice of adequate WAP functions on the basis of the web interface	Realization of: Use Case Scenarios, WML GUI's Programming of: back-end ASP code WML scripts	Implementation of the WAP application and parallel testing.
Basic data	Document describing the GSM Pro WAP interface and its main features.	Document describing the main features of the GSM Pro WAP interface	Documents describing different WAP model alternatives.	Documents motivating our choice of applied WAP model and applied programming language	Detailed description of the technical solution	User manuals
Participants in the discussion	GSM Pro Staff We - in the role as system developers	GSM Pro Staff, and we - in the role as system developers	We, in the roles of both system developers and programmers	We - in the role as system developers and Programmers	We - in the role as programmers.	Users (GSM Pro Staff), we – in the role as system developers and programmers

Figure 4-2 E. Andersen's' *Systems Development model* applied on the development process of the GSM Pro WAP interface

4.2 The qualitative study: Wapps in a wider perspective

4.2.1 The respondents

The qualitative study consisted of qualitative interviews with experts within the fields of WAP development, WAP usability, mobile informatics, and systems development. Altogether we conducted studies with five persons, namely Didier Chincholle, Bo Dahlbom, Magnus Evert, Johan Hjelm and Mattias Olofsson. As we wrote in the methodology part it was very important for us to get a wide spectrum of experts, i.e. they should not be experts in the exactly same fields. After having done the study, we must say that we succeeded in this matter:

- **Didier Chincholle** is a usability specialist and researcher with focus on interaction design. He works at the *Usability & Interaction Lab, Ericsson Research*. Chincholle is an expert of finding aspects of WAP usage that are there, but somehow hard to identify. In the study he contributed very much with the user perspective in WAP development.
- **Bo Dahlbom** is a scientist, the head of the *Department of Informatics in Göteborg* (professor of informatics) author of many books and the president of the *Swedish Research Institute for Information Technology (SITI)*. Dahlbom holds a scientific and philosophical perspective on mobile IT use and systems development. He is an expert of mobile informatics. In our study Dahlbom contributed with fundamental aspects of mobile IT usage in the society of today and of tomorrow.
- **Magnus Ewert** is a technical specialist and a consultant, working at *Calvia Datakonsult*. Ewert has worked a lot with data communication and is a protocol specialist. He has written books about data communication and WAP. He promoted very much the technical perspective of WAP development in the qualitative study.
- **Johan Hjelm** is researcher and developer working at *Ericsson Research* in Japan. Hjelm is also a representative in the *W3C Advisory Committee* and a author of computer books. He has a profound general picture of all fundamentals related to WAP development. He contributed with a holistic perspective of WAP development.
- **Mattias Olofsson** is a consultant and a developer, working for *Accenture* in Stockholm. Olofsson is working out on the field with real client WAP development projects. In the study he shared experience from real WAP projects, thus contributing with a realistic perspective of WAP development.

To sum it up, our respondents have been very complementary to each other and have made us cover a broad spectrum of WAP development in a systems development context.

4.2.2 The questions

The questions arose from our problem definition, from our findings in the theoretical framework, and from our research study. The purpose for the questions was to give as much input as possible to our wireless application development model. The questions differed between the respondents due to the experts' different expertise areas, and due to the fact that it was qualitative interviews. The dialog between the respondents and us, thus, evolved in five individual ways.

But in general the questions were the following, structured after main area:

- **Traps with WAP applications**
 1. What common traps (practical as well as philosophical) are considered with WAP development?
 2. What type of problems are related to WAP application development?
- **Systems development and WAP**
 3. Do you have any suggestion of how a wireless application development model can be built in order to ease the systems development process? What main differences do you see between WAP development and web development?
 4. What main considerations does one have to have in mind when developing WAP applications?
- **Future killer wapps**
 5. Do you have any ideas of how usage will be in the future? How common will it be to be a "WAP-user" (in numbers or percentage or just an estimate)?
 6. What kind of services will be demanded in the future?
 7. What will according to you be the future killer WAP applications? What will they have in common?

5 The Results

5.1 The action research study: Development of a wapp

5.1.1 Adjustments

Theoretical models and practise are contradictory. Systems development models persuade a systemized way of proceeding, step by step, in order to produce an outcome. But in reality models are seldom exactly followed. Why, you would ask? The easy answer is because models presume simplified, static realities, and do not take fundamentals as *changing environments* and *new conditions* into account, which are very much realistic features in systems development.

Models function as frameworks, something to lean against in the work process, not necessarily something to be precisely adopted. Decidedly, this was also the case in our action research study.

We had Andersen's model as a framework for conducting our action research study, but made some adjustments along the development process to fit to our specific conditions and prerequisites. The model became adjusted to our specific case. As a result of this process a new model gradually evolved – our own development model. This was the definite result of the action research study.

Our aim was to keep Andersen's model in the extent it was possible, but this turned out to be too hard, which led to enforced modifications of some parts of it.

It must be declared that we chose to abandon the defined headings and problem definition headings in the different stages and concentrated on the activities since we found the titles and names, defined by Andersen, to be restricting names for the actual performed activities.

Some activities were also completely abandoned:

- In the first stage of analysis, pre-named *Analysis of the enterprise*, we were expected to do an analysis of how the GSM Pro WAP interface could add value to the organization. This seemed unimportant for us since (as mentioned in *Delimitations*) we do not deal with organizational change analysis in the context of systems development in this thesis. The WAP interface will add value to GSM Pro in the appearance of adding extra features to the product.
- In the next stage of the analysis, pre-named *Analysis of the information system*, we were expected to evaluate and determine the content of the GSM Pro WAP interface. In reality we were given a suggestion of three main functions to implement by Ericsson. It was no issue for us (or for Ericsson staff) to evaluate the content further.

In each stage of the development there was an output, and a crucial stage.

As mentioned before, there also emerged questions from the stages, which later were used in the qualitative study.

5.1.2 Activities

The activities in the different stages in the action research study were:

In analysis:

- Study of the GSM Pro product
- Research about WAP in general
- Research about different WAP solutions (i.e. programming language in combination with data transport mechanism (e.g. COM, SOAP, etc))
- Research about alternative programming techniques for WAP development (differences in comparison to web programming)
- Pre-study about the existing web interface (logic and user interface)

In design:

- Design of various WAP solution alternatives for the GSM Pro WAP interface (See Appendix 8.4: *Different WAP Solutions*)
- Choice of one WAP solution based on the technical platform for GSM Pro
- Choice of programming language
- Choice of adequate functions to the WAP interface (review of the suggested requirement specification)

In realization:

- Realization of use case scenarios
- Realization of WML GUIs:
- Realization of back-end code
- Replacement of HTML with WML in the back-end code
- Realization of WML-scripts

In implementation & test:

- Test in web browser
- Test in various WAP emulators
- Test in WAP phone: Ericsson R380
- Test in other WAP phones: Nokia 6210, Ericsson R320, Ericsson R520

5.1.3 Output

The output of each stage was:

In analysis:

- Understanding of the GSM Pro product including the existing web interface, the general knowledge about WAP technology, and common programming techniques associated with WAP.

In design:

- Documented choices of applied WAP solution, programming language, functions to implement.

In realization:

- Documented use case scenarios.
- First version of GSM Pro WAP application

In implementation & test:

- Modified GSM Pro WAP application

5.1.4 Crucial stages

The crucial/problem stages in the phases were:

In analysis and design:

- Due to the relatively young age of WAP technology there was little material written about which WAP solution and programming language to choose on the basis of performance, platform, competence and other prerequisites.

In realization:

- We had problem finding advanced development tools, for example tools that are equivalent with advanced web development tools, such as code generating editors etc. We also found the error messages in the editors pretty thin.
- We found the inevitably procedure of first being forced to the back-end programming with HTML before replacing the HTML code with WML clumsy and above all very time consuming.
- Our WAP application relied on gateways supporting cookies. This means that if a user is connected to a gateway not supporting cookies, the application will turn out to be useless. This makes a WAP application relying on cookies very vulnerable.

In implementation & test:

- When testing in emulators, we had to choose between Nokia's and Ericssons' emulator. We would have appreciated a more standardized test environment.
- When testing in a "sharp" environment" the procedure of connecting to the operator and WAP gateway, every time we tested the application, was very time consuming.

5.1.5 Aroused questions

The questions (later asked to the experts), arousing in the phases were the following:

In general:

- Which alternatives method (sequential or iterative) respectively programming language is the most appropriate to choose when designing WAP applications?

In realization:

- Is there a more suitable way of doing the realization procedure other than the way we did it? If so, how?
- To what extent can the WAP developer rely on the gateway supporting cookies?

In implementation & test:

- Would other bearer alternatives speed up the process of testing in a “sharp” environment? Are there other satisfactory alternatives for testing WAP applications?

The result of the action research study is summarized in the table below.

When the development process was over, we summarized and generalized the main stages of our work in a model. This model is presented and commented in *Discussion*.

Consequently and as mentioned above, the definite result of our action research study was a model that evolved gradually during the development process.

	Analysis	Design	Realization	Implementation & Test
Activity	<ul style="list-style-type: none"> • Study of the GSM Pro product • Research about WAP in general • Research about different WAP solutions • Research about alternative programming techniques in WAP development • Pre-study about the existing web interface 	<ul style="list-style-type: none"> • Design of various WAP solutions for the GSM Pro WAP interface • Choice of one WAP solution based on the technical platform for GSM Pro • Choice of programming language • Choice of adequate 	<ul style="list-style-type: none"> • Realization of use case scenarios • Realization of WML GUIs • Realization of back-end code • Replacement of HTML with WML in the back-end code • Realization of WML-scripts 	<ul style="list-style-type: none"> • Test in web browser • Test in various WAP emulators • Test in WAP Phone: Ericsson R380 • Test in other WAP phones: Nokia 6210, Ericsson R320, Ericsson R520
Output	Understanding of the GSM Pro product including the existing web interface, knowledge about WAP in general, and common programming techniques associated with WAP.	Documented choices of applied WAP model, programming language, functions to implement.	Documented use case scenarios. First version of GSM Pro WAP application	Modified GSM Pro WAP application
Crucial stages within the phase	Due to the relative young age of WAP technology there is little material written about what WAP solution and programming language (for back-end code) that are the most adequate to choose on the basis of performance, platform, competence and other prerequisites.		<p>We had problem finding advanced development tools, for example tools that are equivalent with advanced web development tools, such as code generating editors etc. We also found the error messages in the editors pretty thin.</p> <p>We found the inevitably procedure of first being forced to the back-end programming with HTML before replacing the HTML code with WML clumsy and above all very time consuming.</p> <p>Our WAP application relied on gateways supporting cookies. This mean that if a user is connected to a gateway not supporting cookies, the application would turn out to be useless. This makes a WAP application relying on cookies very vulnerable.</p>	<p>When testing in emulators, we had to choose between Nokia's or Ericsson's emulator. We would have appreciated a more standardized test environment.</p> <p>When testing in a "sharp" environment" the procedure of connecting to the operator and WAP gateway every once running the application was very time consuming.</p>
Questions to ask the experts, derived from our action research study:	Which alternatives method (sequential or iterative) respectively programming language is the most appropriate to choose when designing WAP applications?		<p>Is there a more suitable way of doing the realization procedure other than the way we did it? If so, how?</p> <p>To what extent can the WAP developer rely on the gateway supporting cookies?</p>	Would other bearer alternatives speed up the process of testing in a "sharp" environment? Are there other satisfactory alternatives for testing WAP applications?

Table 5-1 The result of the action research study

5.2 The qualitative study: Wapps in a wider perspective

The results from the interviews are presented below. As mentioned above, the questions differed from one expert to another. Due to the variety of the experts' specialist areas, and due to the fact that it was dialogue interviews, each interview therefore evolved in an individual way.

The respondents' answers are quoted in normal text, and our questions are written in bold text.

5.2.1 Didier Chincholle

Interaction Designer, Usability and Interaction lab, Ericsson Research, Kista, Sweden

What are the main differences between WAP and web when it comes to usage?

Different WAP-phones demand different design of applications, mainly due to differences in displays, browsers but also user interface and navigation models. WAP is not a substitute for web, but instead a complement. Developers should therefore not try to add as many functions as they can in their WAP-applications, but instead focus should be on what is really necessary and usable.

It is important to find something that you can't find on the Web today, something that will be unique for mobile use. WAP and the Web are two completely different medias. For example, the WAP client is not a good input device, which the client in the www-model is. If a user wants to sit and work with something for 2-3 hours she will use her PC and definitely not her WAP phone. It is important to be aware of the situation, and adjust to it.

The WAP phone is more an output device, than an input device. You will not sit reading long text documents in a WAP phone, for this purpose, the stationary computer is a better alternative. For example just take the process of typing an ID and a password with various characters - this is easy done with a PC keypad, but totally frustrating to do with a WAP phone.

What will be mobile future killer apps?

I think it is important to think in terms of "one-click-away" apps. To emphasise simplicity - the service should just be one click away, not five clicks. This is because it costs money to be connected (this is correct when running WAP over GSM; this will be wrong with GPRS since you pay as you go), on-line, and it would be very frustrating for a user to click 20 times and eventually end up at a dead-end.

Wapps should not be complicated and expensive. They should be free, simple and have push features. Killer wapps are both "time-saving-apps" and "time-killing-apps". They shall contain the right information for the right people - kids have appetite for some kind of features whereas adults prefer other kinds of features. Killer apps are content-based apps - the content is what is important. As an example of a good

content-based simple service, there is a SMS service provided by the airline SAS, which just pushes an SMS with the latest scheduled departure time for a flight number typed by a user. It is simple, fast, and pretty cheap, (even though it's not a WAP application).

Moreover, I think it is important to personalize WAP applications. The phone is supposed to be a personal tool, something that can be customized to personal preferences. It will be important to design personal services. Users want personal information, not as general as it is on the Web.

What should WAP-developers focus on?

Get to know the users. Defining the user target group must be the first step in the development process of wapps. It is a crucial factor for the design and the continuous development process. There is something for everyone; it is just a matter of finding the right thing for the right person, which is not always simple.

Convenience is a keyword in WAP-development. For example typing in text in a WAP phone is not convenient - it is pretty tricky. Therefore, wapps should be designed so that it is convenient to use them. They should be adjusted to the user's environment. For example when the user is driving a car, she has only one hand to manage the phone with - such things have to be considered. The user's situation has to be considered.

Why has I-mode become such a success in Japan?

One of the reasons why I-mode has become so popular is due to the fact that it fits the Japanese environment, with small rooms, and entertainment-oriented culture. A PC is not as common in Japan due to the fact that there is not enough space in Japanese homes to have room for a PC, therefore an I-mode phone is more convenient. I-mode success is also about the quality of mobile services, the right mobile devices for navigation, they have a joystick, for displaying the right content - they have large and colour screens. It's also that you pay as you go with I-mode!

What about future aspects of WAP, like GPRS, and the convergence between PDAs and WAP-terminals?

GPRS means better transport speeds, but the problems with the WAP-terminals will still remain - they will still not have displays large enough. As an analogy - it won't help you to have a Porsche if you are not able to use its full capacity.

Neither do I believe in convergence between PDAs and WAP terminals, because each of them is good for their specific situation and will both be demanded.

Lastly, if you compare the Web today and the Web five-six years ago, when there were just text-browsers, the difference is enormous. I think when we in 2-3 years from now will look back on 2001 and the Mobile Internet of today, it will be the same - there will be evidential differences.

5.2.2 Johan Hjelm

Senior Specialist, Ericsson Research Japan

What common traps (practical as well as philosophical) are related to WAP development?

Practical traps are when developers try to take existing applications, which often are designed without regard for usability, and apply them to the WAP environment. Two wrongs always make more wrong. Also, I believe (somewhere in between practical and philosophical) that designers do things for the wrong reason. For instance, many web pages are designed to preserve a graphical identity, rather than enable the user to access information. It is the same with the WAP environment.

Another common mistake is that designers try to apply what they know from the PC environment, or worse, Mac. The WAP environment does not support this. Often you also see sequences of interactions that impose a very high burden on the user, mentally as well as manually (i.e. the number of key presses is too high). And they think in terms of pages, which have to be fetched from a server, when WAP is designed to create self-contained interaction sets using WML-script to validate input. You finish one deck and then retrieve the next. This decreases response time per card, since you retrieve them as a group.

Finally, applications are developed for the wrong reasons. The mobile environment is used for quick access to urgent information, such as weather, timetables etc. Designing an application in the mobile environment means designing for a sparse environment where rapid interaction means higher user satisfaction. Many designers do not understand this.

Of course, some of the critique against WAP technology is justified. But it is mostly a matter of operations, rather than technology. For instance, WAP over GPRS gives an experience that totally shames WAP over dialup. And even there, using ISDN connection instead of a modem pool can drastically cut the connection time.

What main considerations do you have to have in mind when developing WAP applications?

Mainly, user interactivity, self-contained decks, and that the user is not looking at a graphic design - she is accessing information.

Do you have any ideas of how usage will be in the future? How common will it be to be a "WAP-user" (in numbers or percentage or just an estimate)?

100 % of all mobile phone users will be using the Mobile Internet, as what we know today as WAP will be known in the future.

What services will be demanded?

Services making my life easier just now, e.g. position-dependent information services like *Gula Sidorna, Nära Dig*.

What will, according to you, be the future killer WAP applications?

The killer app is convenience. If WAP is more convenient than other media, note that the competition also has to include newspapers, magazines, radio, TV – any means a user can get information from, then WAP will be a winner. If it is more inconvenient, it can only lose.

There are only 24 hours in a day, and there are no empty spaces. Something new will have to replace something else.

5.2.3 Magnus Ewert

Consultant, Calvia Datakonsult

What types of problems are related to WAP application development?

The WAP application is in general not a very user-friendly application. This, mainly because of several hardware limitations like limited keypad, display and memory etc. There is nothing wrong or user-unfriendly about the WAP protocol stack.

When it comes to finding information, searching information, “wapping” is not so convenient due to the fact, once again, that the mobile phone is a pretty clumsy surf-tool. Moreover, the ordinary WAP-user has often got access to a stationary terminal, which is far more suitable for this purpose.

The awareness of the limited hardware is a needed requirement when developing effective and useful wireless applications. It is impossible to transfer a complete web application into a WAP application. If this is done, the complexity of the application will make it worthless. There are a lot of examples where developers have tried to do this conversion, and afterwards, when the failure becomes a fact, they just blame the failure on the limitations of WAP, rather than on the software itself. When to design a WAP application, you have to think in an entire new way, see WAP as a complete new medium, and not as a replacement medium to the Web.

What choice of back-end programming language is most suitable?

The choice of the back-end programming language is quite insignificant and is no critical factor in the development cohesion. The performance of the common languages used today in the WAP context does not differ a lot. Also the fact that relatively small amounts of data are sent makes the languages indifferent. Therefore the programmers’ knowledge and interest together with the hardware platform, will constitute the main factors when choosing an appropriate programming language, not the relative performance of the programming language.

What common traps are related to WAP development?

Describing text, advanced navigation, and menus are elements that I prefer not to have in a WAP application. The thing is that the most characteristic parts of the web are, simply, not possible to convert into WAP. Many claims that WAP development is about picking a few, well-chosen parts from the web interface and then just convert them into WAP. This leads to far too complicated applications. I thus want to point out that it is nothing wrong with WAP as a protocol - it is well designed and well

made. The problem is rather the WAP applications not taking the WAP prerequisites into account. Menus are common in WAP apps, but due to the WAP phone's limited display and keypad it is necessary to keep them simple.

To what extent can you rely on hardware support like cookie handling in WAP today?

There is a great danger in relying on different hardware supports. It is easy to follow the trend, to use the latest hot functions, but in fact, it is really not a good way of developing. I assert that the most important in the development process is to focus on the creation of simple but robust functions and thereby guarantee the hardware support, and that the application works.

Is there a specific development method to prefer when to develop WAP applications?

No, I do not see any differences between web- and WAP development in this aspect. The choice of systems development method depends more on the specific project itself than if web apps or wapps are about to be developed.

What will, according to you, be the future killer WAP application?

Killer WAP applications will be simple, without sophisticated functionality. The key words are: *few*, *simple* and *robust* applications. WAP is something like an intermediate unit between text terminals and the web, it is important for developers to be aware of this.

WAP is no substitute for the web - it is a completely different medium! The WAP device is not a portable web browser! To surf and explore the web is something you do with the stationary computer, not with your phone. The main future WAP service will according to me be some sort of subscribed information service.

WAP can be seen as a complement to the Web. In the WAP environment a portable browser is included, but of natural reasons this browser is much simpler than the browser used on the Web. It is also important to remember that when "wapping", it is not the Internet that is being accessed, but instead a parallel world on the Internet, the Mobile Internet.

And once more, I would like to stress that WAP is made for, and should be used for, sending and retrieving less complex information, than is done on the Web.

What about future aspects of WAP and WAP usage?

I think that 3G will give the standard many, and completely new possibilities, and at the same time, sharpen the demand for the device.

The time it takes to connect to the operator and the transmission speed will improve with GPRS. The future bearer alternative, UMTS, will improve the transmission speed further. UMTS will, by the way, be launched in Japan this autumn (2001).

I think that WAP will become a hit simultaneously as the release of GPRS and WAP 1.2. WAP 1.2 contains the "push" functionality, which will be an important factor for

its success. Unfortunately, people are today not able to upgrade their phones to new versions of the WAP protocol. This means that people have to buy new phones to be able to take part of new features, which will, consequently, delay the impact on overall usage.

My opinion is that WAP will be a hit. Or more precisely, the mechanisms and functions related to WAP will be successful, although it will not be in the appearance of "WAP", it might be in another technological standard. However, this technology with wireless applications and the Mobile Internet, will for sure strike when the technical framework is sufficiently deployed, naturally when 3G will be released. When this happens, companies will discover the commercial possibilities that WAP has to offer and this will thus at the same time gain the evolution of supportive software tools for WAP-development.

5.2.4 Bo Dahlbom

Head of the Department of Informatics, Göteborg University

What is your general opinion about WAP and wireless services?

I am of the opinion that the protocol WAP will not be long lasting on the market - new bearer alternatives like GPRS and UMTS will make other protocols appear as more interesting alternatives.

When it comes to wireless services one can divide them into consumer oriented and business oriented services. I think that business services will be the most popular, and the most common services on the market. Services related to your job like e-mail, web, intranet, business systems, support systems - things you do at the office will be needed and highly demanded. Services built on mobility will be demanded. When you are on the run, going somewhere, it can be good to know your position, find the right address, and check the agenda before stepping in on a meeting. You might need to prove you identity, and you might want to pay for something, these kinds of services can all be done when you are mobile, and therefore they can be regarded as mobile services, and possible candidates for being performed through a mobile terminal.

How about trends in mobile usage?

When am I available? When can you reach me? Well, only when I am mobile, out there running to a meeting, between two places. When I am sitting here in a meeting I turn my mobile phone off! I want to be off-line and not disturbed.

Future mobile killer apps will be, according to me, services growing from the past in a new form. As an example, take e-mail, which has been on the market since the 60's but then in the 90's suddenly it exploded in a new form. So services, which are already there, already invented, will probably be re-invented in new forms. There are certain things that characterize the 90's. First we have the big screens like web browsers, TVs. This is media. Secondly we have applications related to your job, like word processing applications, e-mail programs, used in laptops. Lastly we have the phone, which represents communication, done in your mobile phone. There is obviously a strive to have everything you can in your mobile terminal. People want

everything everywhere, and everything should be wireless; laptops when you travel, your mobile device when you are on your way to a meeting, etc. And at the same time there is a desire to have more and more features in your mobile device, more applications, more games, more functions, and so on.

But today, it makes no sense in “surfing” with a mobile phone, it is meaningless. And you can’t really utilize the e-mail functions so good, because you can not read the attachments, because the needed applications to do so, are not supported by your phone. So I think there is a strive for the phone to be more and more become like a PC, have more and more applications. Just as there is a strive for the PC to become more and more powerful.

Are there any social phenomena today that will have an impact on future mobile usage?

The fact that people work more and more. And the fact that globalisation increases competition. Companies compete more and more, which means that people compete more and more. People are measured and compared with each other to a larger extent today than ever. For example, the fact that Japanese schoolgirls sit around sending funny pics to each other with their I-mode phone is just because they do not yet have the possibility to do home work through their I-mode phone. As soon as this opportunity occur, they will do their home work instead of sending pics simply because the competition is so hard that they will not take the risk wasting their time with something that will not increase their competitiveness. This is a general phenomenon, an American phenomenon - increased competition even for kids. Everything is a race! Therefore I believe killer apps will be related to work, apps that can improve the competitiveness for a company, or even a person. This is also where the capital and the investors are.

Another social phenomenon is that the boundaries between work and free time are becoming more and more fuzzy. Work becomes entertainment and vice versa. And entertainment is mostly consumed by lower class citizens, like in America. And the harder the competition gets, more and more people become beaten, and consequently, entertainment consumption increases more and more.

People nowadays have the possibility to work with what they used to do when they were off work. For example kids play computer games and after a couple of years they end up taking jobs as game designers. Another example is that years ago, reading a paper was before considered being something you did on your spare time, nowadays you are forced to read several papers related to your work - just to keep updated with your job. So maybe, future killer apps will be applications related to work and education but in the form of entertainment.

5.2.5 Mattias Olofsson

Consultant, Accenture

What are the main characteristics of wapps?

There is a trade-off today between WAP usability and performance. If you try to enhance performance it will be on the cost of usability and vice versa. When it comes to functional design I think it is important to be aware of the physical delimitations, like the small displays, the keypads, etc. For example the size of the WML decks are crucial, the memory capacity differs between terminals and are above all very low in WAP-terminals.

What do developers need to consider when developing wapps?

In a project, I developed a WAP-portal, I used s style sheet processor to get around the problem with different displays in different terminals. So, the style sheet processor generated different code depending on the WAP-client. Developers have to be aware of different interpretation of WML in different browsers. And not only do the browsers interpret WML differently; the WAP gateways interpret WML differently as well, depending on the version of the gateway. The fact that there are so many different browsers and terminals means that WAP requires a lot of logic on the presentation layer. The code can be up to five times as large in WAP application than needed in a corresponding web application. This means that it extra important to do component testing before putting modules together. To back track will mean a lot of job in the WAP apps due to the extensive logic needed.

Another thing to consider is to cutting down as much functionality as possible if you have a web application as basis for developing. Also to planning navigation is important, to having a flat hierarchy is often good. I also think one should be careful re-using web-logic. This can be dangerous and distracting. Developers must also consider how many different terminals that should be used, and adjust to these terminals. A tip is to start designing static WML-pages, and then fill up with back-end code.

In general, what is your opinion about WAP?

WAP has been boosted without really having content. So, a catch-up period will now take some time. WAP is not reliable, even GRPS will not make it more reliable. WAP is good as a protocol but worse as a concept.

What will be the future killer wapps?

Future killer apps will be applications such as positioning apps, entertainment apps, and bank services. I do not believe to much in the push-feature. I would go mad if I got commercial alerts in my phone every time walking by a shop!

6 Discussion and Conclusion

6.1 A short review of the thesis

In the beginning of the thesis we outlined the main question as the underlying incentive for this thesis; if the criticism to WAP has its origin in the development process, and if so, how the development process and its focus could be changed, or even optimised in order to develop quality applications, killer wapps. We narrowed this question to a more precise problem definition; to investigate how a development model can be designed, in order to support the wireless application developer in the development process, and to be a tool for developing quality wireless applications, killer wapps.

In order to answer the problem definition we chose a course of action of three studies (literature-action research-qualitative interviews), in which we investigated if there are any major crucial stages in the process of developing wapps, if the development process of wapps differs from a more traditional development process, and if there are any major philosophical and practical traps related to wapp development. All these questions were encapsulated in the studies presented in previous chapters.

So now what? What have we come up with so far? Can the WAP criticism be backtracked to the development process of wapps? And how about this model for developing killer apps, how can it be designed?

6.2 Our conclusion

This thesis proposes that *there is a number of considerations, which have to be made in the process of developing wapps, and that the development process, thus, is one critical factor how mobile users and the critics will see wapps. Deductively, the development process has a significant impact on the WAP concept as whole, and thus, also on the WAP criticism.* This is our conclusion, based on our own practical experience with WAP application development, and our interpretation of the expert interviews.

After having completed the studies, it seems clear: if developers would consider some given philosophical as well as practical traps related to wireless application development, defined in this thesis, the supply of quality wireless applications on the market would improve. If the development process is not properly undertaken – if the right considerations are not made - it will have an immediate negative effect on the application itself, and in turn increase the risk of being object for massive criticism.

For us to give answers and try to determine *how* important the development process is as a factor for how the WAP concept is met on the market and by critics would be pure speculation. We know that there are other critical factors as well apart from the software factor that have impact on how WAP is met by users and critics: hardware prerequisites, market maturity, consumer behaviour, etc.

6.3 Introduction to our model

The remaining part of this chapter focus on how the development process, in accordance with our findings, can be optimised in order to develop quality wireless applications, killer wapps.

As presented in the results of our studies there are indeed lots of things to consider in the development process of wapps. Our action research study indicated on a number of crucial stages in the development process, the qualitative interviews gave us a number of philosophical as well as practical traps, and in both studies there were clear examples of that the development process does differ from traditional application development in some aspects.

One way to present these factors, backing up our conclusion, would be to line up one factor after the other, from the study material. We decided though to do it in another way, namely, to present them in a more adequate context – in a systems development model.

This model summarizes our findings and conclusions - the most important considerations to be aware of when developing wapps, in the format of a development model. And importantly, the considerations are placed in their right place along the chain of the development process. The model aims at answering the question of *when* to consider *what*, instead of simply *considering* without context.

The model's mission is to be a useful framework for developing killer wapps. The model is the total outcome of this whole thesis project, and summarizes the core findings of the entire thesis project.

6.4 Stepwise design of the development model

Below, the stepwise design of the wireless application development model is presented. First, the model on the basis of the definite result of our action research study is presented. Then, a review of the qualitative interviews in the study is presented and adequate views from the interviews are added to the model, thus improving the model with expert opinions. Lastly, before the complete model is presented, a generalization is made in order avoid the model to be narrow and WAP specific. A more general model, with its intended purpose of serving as a normative platform for future development of killer wireless applications, is presented.

6.4.1 Defining the main phases

The model is built on the result of our action research study. We have outlined the core findings of this study and adopted them in the format of the model. For every phase or stage in the model, it is first suggested of how we recommend developers to proceed in the current stage. The recommendation is then followed by a short description of how we did in our specific case when developing the WAP application at Ericsson, thus giving realistic support. But first, before the various stages are sequentially described, the whole model is presented for the reader a glance at the whole picture, that is about to be presented.






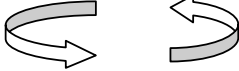






Phase	Analysis & Design					Realization, Implementation & Test		
Phase action	Idea generation	Delimitation	Development investigation	Choices	Recycling	GUI development	Coding	Replacement
Development method								
Activity	Identify all desirable functions wanted in the WAP application	First step: Identify all needed functions wanted in the WAP application, the core functions Second step: Which functions will fall off due to technical aspects?	Analyse what WAP solution to implement Analyse what programming language to implement	Choice of WAP solution Choice of programming language	What functions can be re-used if from an already existing application?	Realisation of GUIs for mobile device	Realization of back-end code together with HTML	Replacement of HTML with WML in the back-end code and realization of WML-script
						Testing: Test in web browser Test in various WAP emulators Test in various WAP Phones		
Output								
	A large number of realistic as well as unrealistic functions	A delimited number of desirable realistic functions	Understanding and opinion of the above mentioned issues	Choices regarding WAP solution, programming language	Re-useable logic, methods and functions	WAP prototype		

Figure 6-1 The development model based on the action research study

6.4.1.1 Idea generation

As a first step in the development process of a wireless application the purpose of the application must be determined. We presume, that in any systems development project for a wireless application it is important, and a natural first thing, to consider what functions are wanted in a wireless format. The question to ask must be:

What functions are really desired for the wireless application?

Of course, it is easy for participants in the discussion to say that it is desired to implement all possible functions in the wireless application. But, according to us, the question must be more precise and more like: what functions are *preferable* to have in a wireless application to complement a stationary application, or even better - what functions are explicitly wanted in a wireless format for a mobile situation. These are the questions that have to be raised in order to identify desirable functions for a wireless application.

The figure below is a graphical illustration of all desired functions for the wireless application.

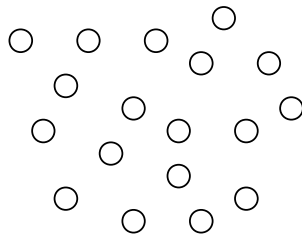


Figure 6-2 *Identified desired functions. The circles represent desired functions.*

The output wanted is preferable and desirable functions, realistic as well as unrealistic.

When we, in our case, were assigned to develop a WAP interface to GSM Pro we immediately got a suggestion of three desired functions to build the application upon: add member, delete member and list members, i.e. it was already informally decided upon, what functions to implement. In our project, the idea-generation phase was in a way already over and completed by GSM Pro Staff.

6.4.1.2 Delimitations

After the function idea generation is done in the previous stage, the functions must be evaluated more in detail. The first thing to do, when entering the delimitation phase, is to ask:

What functions are really needed for the wireless application?

This question is raised in order to identify the *core functions* of the wireless application, i.e. functions that justifies the existence of the wireless application. The

core functions are few and bearing, and simply functions that cannot be left out. Without those core functions continued development of the wireless application cannot be called for. Functions desired, but not really needed for the application, do not belong to the core functions, but are for that reason not rejected - only put aside until the next step in this phase. In the figure below, the core functions have been surrounded by circle.

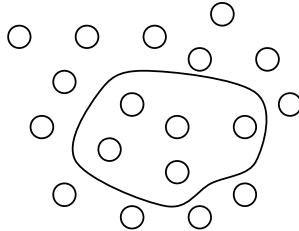


Figure 6-3 *Identify needed functions. The marked area contains the core functions.*

The second thing to do in this phase, is to ask:

What functions are realistic to implement from a technical point-of-view?

This involve delimitation of the functions defined in the previous phase by taking technical aspects into account, and also to investigate whether the core functions can be implemented taking the technical aspects into account. If the core functions will fail on these technical grounds the whole wireless application and its intended purpose will be closed.

The technical aspects involve the hardware prerequisites for mobile devices, network capacity, gateway version, etc. For example, what limitations and opportunities does the mobile device have? It is important to identify key variables such as security, portability, usability, and performance in order for them to serve as decision variables.

Even functions that technically can be implemented, can at the same time suffer from reduced usability aspects, which are partly due to a poor technical solution and partly due to weak human capacity. For example, functions requiring a lot of text typing on the mobile device suffer from reduced usability. The manoeuvre of typing in text on the phone keypad is complicated, because of the small keypad on the technical side, and because of lacking patience on the human side.

Additionally, functions that can be technically possible to implement, but where an implementation of them would mean a very complex development process, requiring an unmotivated amount of resource in proportion to what the function will add in terms of “value”, must be carefully considered in order to decide if they should be implemented.

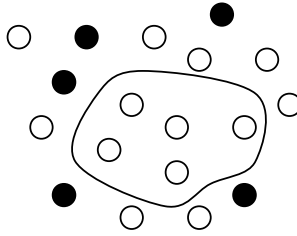


Figure 6-4 *Identify realistic functions. The filled circles represent unrealistic functions*

The output of this phase is a number of desirable realistic functions ready to be realized.

If one or more core functions fail on technical grounds (if a one or more circles are filled within the marked area, see figure 6-4 above) - a decision for closure of the wireless application project, until the technical prerequisites have reached a satisfactory level for proceeding realization, should be called for.

6.4.1.3 Development investigation

The main objective after having completed development investigation is to have a clear opinion about the following three matters; what WAP solution to implement; what programming language to use.

By doing research in these areas the developer will create an understanding of different alternatives, and their respective strengths and weaknesses.

To do research about different WAP solutions, we mean considering alternative options, depending on manufacturer, technical platform, and other prerequisites.

When doing research about different WAP solutions, it is unavoidable to get an opinion of what programming language to choose, because WAP solution and programming language are often closely connected. So often, opinion about programming language is often gained automatically when studying WAP solution alternatives, otherwise it needs to be studied exclusively.

In our case, we basically did research about two alternatives, Microsoft's ASP (Active Server Pages) solution and Sun's JSP (Java Server Pages) solution – and compared them to get an understanding of their respective qualities.

6.4.1.4 Choices

As a natural follower to the previous stage, it is in this stage time to make the necessary choices on the matters that have been the objects of research. Consequently, WAP solution and programming language must be decided upon.

By making these choices there are certain decision variables for each choice that have to be carefully considered. Depending on the project's objective, the variables will have different weight. For example, if the main objective for the development project is to be optimal in the aspects of cost and time, certain variables are assigned higher weight than they would, if (for example) a competence enhancement in the project group would be the major objective for the project.

The decision variables to deal with when choosing WAP solution and programming language are according to us, the following:

- **Competence**

With competence, we mean personal, in-house and surrounding knowledge, and experience, which the project can gain from. For example, if a majority of the competence in a project group lies in a certain solution, this aggregated competence should be well considered when choosing solution.

- **Technical factors**

Considerable technical factors can be everything from in-house operating system to available development tools. For example, if a company, totally dependent on products of a special brand (development tools, programming languages, environment), is about to develop a WAP application, it will in such an extreme case be rather complicated and costly to apply a solution suitable for another technical platform. (New development tools have to be purchased, environment has to be adjusted, etc.)

It could even occur that the WAP application is supposed to interact with already existing applications and databases of certain types, e.g. Microsoft. In this case it would be easier to implement a WAP application written in a Microsoft integrated language than it would be to write it in another programming language.

If the WAP application has certain performance requirements (speed, load, etc) the choice of programming language can be very crucial, which will have an immediate effect on this choice.

- **Motivation**

This decision variable is the softest one of those mentioned.

When to develop a WAP application, it can be stimulating, a great challenge and a new adventure for the project and the project members, to throw themselves into the work process of a completely new technical solution. If a new technical solution is chosen (with "new" we mean new to the project members) this will probably lead to an enhanced competence level for the project group, which must be considered as a positive synergy for the project as whole. And not only the project as whole will gain, the individual project members will gain from this experience as well, since they will learn and develop in their roles of profession. Such motivating factors, as those above mentioned, will therefore have a strong impact on the choice of solution.

In the definite choice of WAP-solution and programming language, all of the above mentioned decision variables, have to be well considered and weighted depending on the desired outcome of the project.

The output of this stage are choices on the matters of what WAP solution to implement and what programming language to use.

Just to give an example, the choice of WAP-solution, and as an appendix to this choice, the programming language, in our case was a result of the same factors as those mentioned above:

In-house competence among Ericsson GSM Pro staff was higher for the WAP solution we chose than for the other candidate solutions.

Moreover, we were to deal with an almost equal cost of learning no matter what solution or programming language that was to be chosen. This, due to our relative limited personal experience in the area of WAP programming. Thus, our own competence was no decisive factor, for the choice of a specific solution.

There were no specific technical requirements for our WAP application, in terms of performance or capacity. But nevertheless, there were some technical prerequisite that became decisive for the choice of WAP solution and programming language:

First, the fact that the Ericsson GSM Pro Staff mainly is working in a Microsoft environment, was one technical factor. This means that operating system, development tools, servers, transport mechanism (COM), etc, all are Microsoft products. Secondly, the fact that the already existing back-end layer of the web application was implemented by using Microsoft's ASP solution was another technical factor.

These two prerequisites were important in our choice of a WAP solution, We would get a lot "for free" if we chose a WAP solution benefiting from these technical factors.

The motivation factor was no decisive factor for our choice of WAP solution and programming language. In fact, whatever WAP-solution and programming language we chose, they would all be fairly new and adventurous for us since we were inexperienced in this particular area.

6.4.1.5 Recycling

In this stage the developers have to check in an already relevant existing application (if any), in order to see if some logic, methods or functions can be re-used.

Therefore, it can be time saving and facilitating in the development process to have a look at an already existing relevant application, and maybe re-use, before starting off the design of the new wireless application.

There must be an adjustment of how much code should be recycled. Recycling should have the intention of getting usable ideas from existing logic in an application, more than being focused on just blindly recycle in a copy-paste spirit.

Of course, this stage is only valid for development projects, which have an already existing application with methods and functions to supply.

The output of this stage is, if possible, re-usable logic, methods, and functions to bring into the design of the new wireless application.

We chose to include this stage in the model because we believe it is a rather normal phenomenon, to transfer certain parts of an existing web application into a wireless application, at least this was the case for the WAP application we designed for Ericsson. To some extent, we re-used already existing functions and simply changed the presentation layer (WML instead of HTML). We also benefited a lot from the logic in the web application in order to design our own logic in the WAP application.

6.4.1.6 Graphical user interface development

As the heading reveals, this stage involves the activity of designing graphical user interfaces for mobile phones.

In the theoretical framework, we described the importance of usability in wireless applications. The usability aspects have to be carefully examined in the GUI design. There are a lot of things to consider: small displays, limited bandwidth, different browsers, etc.

We are of the opinion that it is better to do the WML programming (GUI design) before and separate to the back-end coding, when developing a WAP application. This way of proceeding will make it easy to get a general picture of the whole application and its usability features. It is easier to sit and edit just WML code than to be forced to edit in the back-end code, when small graphical adjustments are to be made.

According to us, a way to go when designing these GUIs is to come up with use case scenarios for all relevant functions. This is a good way of getting an overview of the application and to cover all possible modes that can occur when using the application. When these are done it is quite simple just to develop the interfaces with the use case scenarios as basis.

There are a certain number of usability rules to follow when designing GUIs for mobile phones, for example: avoid a lot of text, avoid graphics, use simple navigation, etc. Since our thesis does not deal with usability in particular we will not go into this further, instead we refer to *Appendix 8.5: Graphical user interface development: Usability rules*.

6.4.1.7 Coding

After the GUIs have been realized it is time to realize the back-end code.

We suggest that it is better to implement HTML in the back-end code than to implement WML straight away. One reason to proceed in this way is because there are very few good development tools supporting WML development on the market. By using HTML instead of WML in the back-end code, the development can be focused on logic instead of the presentation.

When developing wireless applications, it is crucial to split the critical steps along the process; one critical step is the realization of the WML code, and another is the realization of back-end code. We are of the opinion that it is better to first make the WML code debugged before getting on with the back end code.

When to realize the back-end code it is easier to do this by using a rather insensitive presentation language (HTML) in order to have focus on the back-end code itself. If back-end code would be realized with WML straight away, it would be difficult to backtrack and localize the real source of error since there would be two possible sources of error. With this we do not mean that errors cannot be made in the HTML-code. But the truth is that HTML-browsers are far more error tolerant than WML browsers, which makes HTML a better option as presentation language in the realization of back-end code.

The fact that HTML has better presentation prerequisites than WML makes it easier to work with when performing tests.

Except for this remark about implementing HTML before WML, back-end coding of wapps does not differ in any particular way in comparison to realizing back-end code when developing a web application.

6.4.1.8 Replacement

After the back-end code can be considered debugged and realized, it is time to replace the HTML code in the back-end code with the graphical user interfaces realized in WML. This process, however, demands certain modifications in the code. It is not so simple to just do a copy-paste maneuver, the WML code might need to be split into pieces and modified in order to fit the back-end code, and vice versa.

Not to forget, it is necessary to store the files with HTML in the back-end code, in order for future modifications and supplements to first be realized and tested in this code.

Realization of WML-scripts is done as a last step in this stage, after the WML-code code has been integrated with the back-end code.

6.4.1.9 Testing

Testing is performed throughout all Realization & Implementation stages, but with different testing tools in the different stages.

Firstly, when WML coding is realized, testing is easiest done in emulators. Secondly, when the back-end code is being realized (HTML-version), testing is performed in traditional web browsers. Thirdly and lastly, when the HTML code is replaced with WML, sharp testing can be performed in various WAP phones (WAP browsers), in combination with emulator testing. It can be mentioned that the process of testing “sharp” in a WAP phone is much more complicated and time-consuming than performing tests in WAP emulators. But anyway, to conduct sharp testing is the only way to find out how the application really behaves in a realistic situation, and in a specific browser.

In the future, along with technical progress, there might evolve better testing alternatives than today's best option, according to us, of using emulators when testing. With better connection speeds and bearer alternatives sharp testing will eventually replace emulators.

6.4.2 Adding expert views to the model

After the qualitative interviews were completed, we tried to identify the core findings, and to discover a pattern in the qualitative interviews. The result of this process is divided into five categories. Each category is presented by first quoting one of the experts. These quotes are then followed up with our interpretations of the experts' opinions and views on the quoted subjects from the interview material.

At the end of each category, one or more questions are outlined. The questions are evoked by us, and are supposed to serve as "quality checks" in the development model, and are called *checkpoint questions*.

The suggested expert views in the five categories are of philosophical character, and are intended to have a positive impact on the potential developers mindset, and on the focus in the development process. Even though we have tried to distinguish the categories as much as possible, the boundaries between the categories tend to be a bit blurry. The most important thing, in this respect however, is not the categorization, but instead the aggregated generated message based on the content of all categories.

6.4.2.1 The medium aspect

WAP is not a substitute for the web, but instead a complement (D. Chincholle)

Chincholle stresses that developers should not try to add as many functions as possible in the WAP application, but instead focus on what is really necessary and usable. Ewert is of the same opinion and claims that it is impossible to transfer a complete web application into a WAP application. He claims that WAP is a complete new medium, and not a replacement medium to the web. Hjelm also contribute to the same standpoint when he explains that a trap in WAP development is to try to take existing applications and apply them to the WAP environment. By doing this, Hjelm argues, WAP applications are automatically designed for the wrong reasons, on the expense of a reduction in user satisfaction.

The above-mentioned expert views evoked the following checkpoint questions for the model:

- Is the wireless application designed for being used in a wireless format with the medium in mind?
- Has the wireless application been enough delimited in terms of functions?

6.4.2.2 Convenience

The wireless killer app is a convenient app (J. Hjelm)

Hjelm means that if WAP is more convenient than other media (newspapers, magazines, radio, TV, etc) for a certain purpose, then WAP is the winner. He stresses, that the services making life easier will be demanded. Chincholle is also of the opinion that convenience is a keyword in WAP development. He means that wapps should be convenient to use.

The above-mentioned expert views evoked the following checkpoint question:

- Is the wireless application convenient to use?

6.4.2.3 Adjustment to the situation

The future wireless killer app will be related to work - apps that can improve the competitiveness for companies and for individuals will be the winners (B.Dahlbom)

Dahlbom claims that the fact that competition today increases in the world in a high pace, has the effect that companies cannot afford wasting time on meaningless activities. Everything is a race, Dahlbom stresses. Therefore, he believes that meaningful applications, which can improve the competitiveness of companies, will be successful. The content is very important. According to Chincholle, content-based applications will be the future killer apps. He argues that such applications should contain right information, for the right persons. Chincholle talks about time-killing apps, and timesaving apps, as given future winners. He also stresses the importance of target focus in application development.

On the same subject, Hjelm says, the mobile environment is used for quick access to urgent information. He means, that to design an application for the mobile environment is to design an application for as sparse environment where rapid interaction means higher user satisfaction.

The above-mentioned expert views evoked the following checkpoint questions:

- Is the wireless application content-based? Does it provide the right information for the right person at the right time?
- Does the wireless application enhance value for the target user group?
- Is the application adjusted to the mobile environment?

6.4.2.4 Usability contra performance

If you try to enhance performance it will be on the cost of usability and vice versa (M.Olofsson)

Olofsson argues that there is a trade-off between WAP usability and performance. For example if a developer cuts down a lot of describing text in an application, it will be faster, but at the same time more difficult to navigate in.

Ewert claims that describing text, advanced navigation, and menus are elements, which should be avoided in WAP applications. He explains that the most characteristic parts of the Web are not possible to convert into WAP. Therefore, he stresses simplicity as a keyword in WAP development. Chincholle also stresses

simplicity, meaning that services should just be one-click away and not be complicated. Hjelm explains that interactions that impose a very high burden on the user, mentally as well as physically, for example to many key presses, should be avoided.

The above-mentioned expert views evoked the following checkpoint questions for the model:

- Is the balance between usability and performance properly adjusted?
- Is the wireless application as simple as it can possibly be without losing usability?
- Is the navigation hierarchy flat enough for being easily maneuvered?

6.4.2.5 Hardware awareness

The awareness of the limited hardware is a needed requirement when developing wapps (M.Ewert)

Ewert claims that the WAP application is in general not a very user-friendly application. He means that there are several hardware delimitations like limited keypad, display, and memory, which have impact on usability. But still, he argues, there is nothing user-unfriendly about the WAP protocol itself. When designing applications it is important to be aware of these technical limits, and adjust to the prevailing prerequisites. Ewert also warns developers to rely too much on different hardware supports, like cookie-support. According to Ewert, it is better to focus on robust functions, not the latest technology features.

On the subject of hardware delimitations Olofsson takes the example, that the memory capacity is very low in WAP terminals, which in turn makes the size of the WML decks a crucial factor. Olofsson further explains that differences in the interpretation and compilation of WML in browsers and gateways also are important things to be aware of.

We claim that, another way to be aware of the prevailing hardware prerequisites is to be aware of the possibilities these provide. The fact that the mobile phone is small, light-weighted with a small display must not necessarily be seen as disadvantage, but instead an advantage. It is easy to carry, smooth to handle etc. The WAP technology provides some special features that are unique for a medium: push-capability and deck functionality, which can, if utilized properly be very effective for usage satisfaction.

To often WAP is directly compared with the Web, instead of being seen as an individual concept, with unique characteristics.

The above-mentioned expert views evoked the following checkpoint questions:

- Are the prevailing hardware prerequisites being carefully considered?
- Are special unique WAP-features, such as decks and push-capability being optimal utilized?
- Is the wireless application reliant on any hardware supports that are not standardized on the market?

6.5 The final model

“The whole is more than the sum of its parts”, is a saying used sometimes to describe the essence of emergence. This saying fits into what we present in this section – our development model designed for serving as a tool for developing killer wapps. Above we outlined the different parts of the model, the phases and the checkpoint questions evoked by us on the basis of the expert opinions. Below the parts are put together, and form a whole.

A normative development model designed for serving as a tool for developing killer wapps? Does it sound a bit too ambitious? Can such a model be trustworthy if two informatics students design it? Well, we are fully aware of that such a model runs risk of being sharply criticized by experienced systems developers and academicians. To our defence, we can only say, that this model, is just one model among others. A model that was built according to our findings and results. We do not claim the model to be ideal. It is only an artefact, the result of a good attempt, in the strive for the optimal.

The final model is derived from what we discussed above in *Stepwise design of the development model*, but is below presented more concise and general.

Before the final model is presented, we explain how we have generalized the model, and what the arrows in the model stand for.

6.5.1 Generalizing and adjusting

For our model to serve as normative development model for wireless applications it has to be rather broad. Who knows, WAP can at anytime be replaced by a new better standard, and this would make our model look kind old fashioned, would it not? We are not going to take the risk of falling in such a trap. Therefore we have tried to generalize the model for it to be adopted on “wireless applications” instead of just on WAP applications. WAP-specific terms have been replaced by more general terms.

We have also decided to eliminate the “Phase” headings: *Analysis & Design*, and *Realization; Implementation & Test*, since the do not say anything particular about our model.

6.5.2 The arrows

As the readers can see in the model presented above, the model contains several arrows. The arrows in our development model represent the *development method* in this model. We are not really sure of, if development method is the proper term to use, but with development method in this context, we mean: how to go about when developing the application. In theory, two different approaches are often mentioned – iterative and sequential (See *Theoretical Framework – Software development models*). When a prototype needs to be developed within short time, the sequential method

might be preferable, but in long lasting development projects, when there is a need to review on regular basis, an iterative method might be a more appropriate way of proceeding. In reality, however, the implemented development method is often a mix of both of these approaches. This is also the case for our model.

As the reader can see in our model, the first four phases have normal arrows. This means that the phases flow in a sequential order. First, the Idea generation is done, thereafter Delimitations, then Development investigation, which in turn results in Choices, followed by Recycling. Each phase is completed and done before the next one begins.

In the rest of the phases it is on contrary. These phases have circular arrows. This means that the phases are iterative, repeated over and over again. GUI development, Coding, and Replacement are gone through iteratively. First, the GUIs are made; the back-end coding is completed followed by the replacement of HTML with WML. Then, to exemplify a realistic scenario, some modifications have to be made. This means that the GUIs have to be re-designed, the back-end code has to be adjusted, and the replacement phase must be repeated in order for the application to get updated. The phases are thus never fully completed - they are just put on hold until further modifications have to be done. In a way they melt together as one big phase, not fully completed until the whole development project can be considered over, and a wireless application is released.

6.5.3 The phases

The phases in our development model are derived from the ones described above (See *Defining the main phases*) and have thereafter been slightly generalized upon.

The phases and their respective activities are:

- Idea generation: Identify all desirable functions wanted
- Delimitation: Identify core functions
- Development investigation: Analyze alternative solutions (including programming language)
- Choices: Chose solution and language
- Recycling: Recycle possible functions from existing application
- GUI development: Realization of GUIs
- Coding: Realization of back-end code
- Replacement: Replacement of front-end language
- Test: Test with different test tools

6.5.4 The checkpoint questions

The checkpoint questions connected to the model are derived from the five categories described in *Adding expert views to the model*.

The questions are:

The medium aspect

1. Is the wireless application designed for being used in a wireless format with the medium in mind?
2. Has the wireless application been enough delimited in terms of functions?

Convenience

3. Is the wireless application convenient to use?

Adjustment to the situation

4. Is the wireless application content-based? Does it provide the right information for the right person at the right time?
5. Does the wireless application enhance value for the target user group?
6. Is the application adjusted to the mobile environment?

Usability contra performance

7. Is the balance between usability and performance properly adjusted?
8. Is the wireless application as simple as it possibly can be, without losing usability?
9. Is the navigation hierarchy flat enough for being easily manoeuvred?

Hardware awareness

10. Are the prevailing hardware prerequisites being carefully considered?
11. Are special unique “wireless-features”, such as decks and push-capability being optimal utilized?
12. Is the wireless application reliant on any hardware supports that are not standardized on the market?

6.5.5 Graphical illustration of the model

Below, a graphical illustration of the model is presented. The model is almost the same model as the one presented in *Stepwise design of the development model* (page 67), with the remark that the expert views (in form of checkpoint questions) have been added. These checkpoint questions are supposed to function as continuous reviews along the development process. They shall be asked throughout the whole development process. This is symbolized with the line at the bottom of the model, containing the checkpoint questions.

Moreover, the left part of the model contains the sequential stages in the model (Idea generation, Delimitations, Development investigation, Choices, Recycling). The development process begins with Idea generation followed by the other stages. When these have been passed, the development enters “the loop”, which contains the iterative stages (GUI development, Coding, Replacement). In this loop, parallel testing will take part, in all iterative stages; this is symbolized with the bottom circular block. The development process will be stuck in this loop until the wireless application is considered constructed, and can be released.

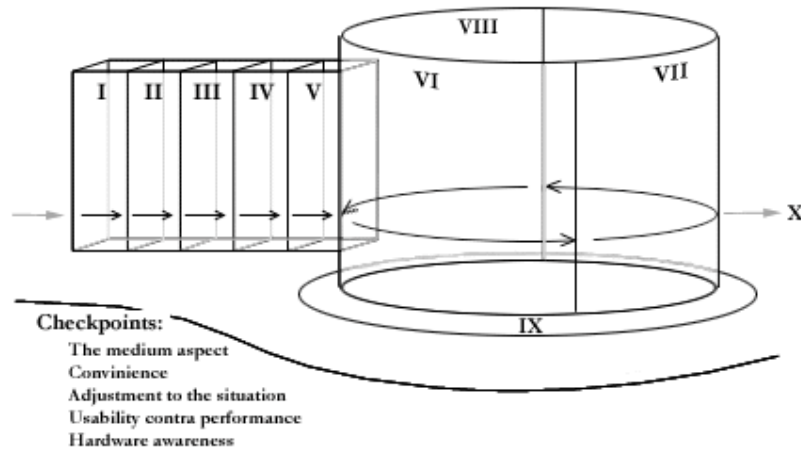


Figure 6-5 Graphical illustration of the final model.

The development process begins with the stage I (Idea generation), followed by II (Delimitations), III (Development investigation), IV (Choices), V (Recycling). Thereafter the development process enters the “loop”, which consists of three iterative stages; VI (GUI development), VII (Coding), VIII (Replacement). Parallel to these three iterative stages, continuous testing is performed, symbolized with IX (Test). It is uncertain, how many “laps” the development process will do within the iterative stages - at any stage, a wireless application can be considered constructed, and released. Then the development process is over, which in our model is symbolized with the X letter. During the whole development process, the checkpoint questions should be asked in order to affect the developer’s mindset, and to keep the development process on track.

6.6 Further research

In scientific reports it is common practise to give recommendations in what areas, further research could be made. “WAP”, “wireless applications”, “future killer apps”, are all very interesting areas and potential candidates for research of any kind.

In *Delimitations* we defined what this thesis is not about. If we turn this delimitation around, we automatically have some interesting areas that might be research alternatives:

- **Consumer aspects of wireless applications and WAP**
 What services do the consumers require?
 Which are the most common alternatives to WAP?
- **Markets aspects of wireless applications and WAP**
 What are critical success factors for mobile internet companies?
- **Technical aspects of wireless applications and WAP**
 How does the wireless protocol technically integrate with the HTTP protocol?
- **Future aspects of wireless applications and WAP**

What is the forecast for WAP technology?

How will 3G impact on WAP usability?

How can I-mode and WAP be united?

A natural research follow-up to our research area - wireless application development in the context of systems development, and the more narrow definition – the process of developing wapps, would be to apply our development model in a real case. To do in-context research, and to let a development team work with our model as a framework, and study this process, would be very interesting. It is first after such a study; a real measurement could be made in order to evaluate the model's quality as a development tool for supporting developers in the process of developing killer wapps.

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8 Appendix

8.1 Problem area: Is WAP a flop?



Figure 8-1 A cutting from the Swedish computer magazine "Computer Sweden" (2001-04-02). The web question of the week is: *Is WAP a flop?* 29% of the 2108 respondents answered "No", 71% answered "Yes".

8.2 Mobile Internet: More about WAP

8.2.1 The WWW-model

Applications and data in the WWW-model are presented in a standardized format. A web browser constitutes the user interface towards the Internet and communicates with a server when to “get” or “post” specific data.⁸⁷

The WWW architecture offers a very flexible and easy used model for development.

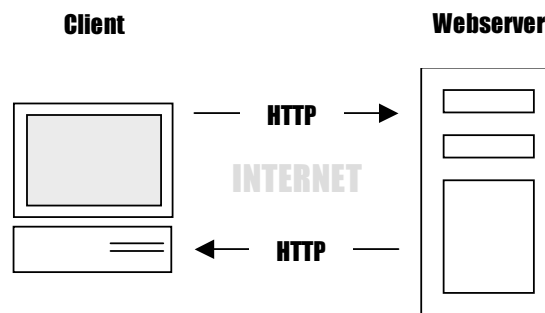


Figure 8-2 The WWW-model

Data communication in WWW:

1. The client/browser sends a request for a data object specified by an URL (Unified Resource Locator).
2. The server responds by sending requested data back to the client.

This model makes it possible for a browser to access unlimited services and applications through the WWW. The developer can, thanks to the standardized model, develop services available to an unlimited number of clients around the world.

Elements in the WWW-model⁸⁸

- ❑ **Web browser**
- ❑ **Web protocol stack** (see figure Figure 8-4)
- ❑ **Web server**

There are two types of web servers in the WWW-model:

- ❑ **Origin Server** – a server, holding applications.

⁸⁷ Magnus Ewert, *WAP, ett steg mot framtiden*, (Lund: Studentlitteratur, 2000), 39

⁸⁸ Ewert, 40

- **Proxy** – software, working both as client or server.

The proxy can make requests towards a server on commission of a client. The proxy is often used together with a firewall (software, which separates clients from servers when no direct contact is desired). The proxy is to be placed between an intranet and the Internet, and beside a firewall.

In data communication, the client requests data via the proxy, which then serves as a server towards the client, simultaneously as it serves as the client towards the server, holding the content, in the intranet.

- **Gateway** – a server functioning as an intermediate between two servers (in the WWW model).

8.2.2 The WAP-model

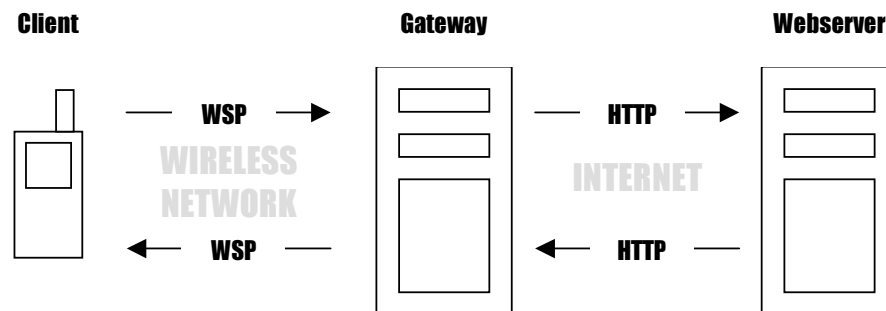


Figure 8-3 The WAP-model

The WAP-model reminds a lot of the WWW-model. The format of data, code, and protocols for the WAP-model have aroused from the WWW-model's standards.⁸⁹ Some simplifications and adjustments to a wireless environment have though been made.

Data communication in the WAP-model⁹⁰:

1. The client sends a request for a data object specified by an URL (Unified Resource Locator).
2. The request is routed to the gateway, which forwards the request to the server in HTTP format.
3. The server returns requested data back to the gateway.
4. The gateway converts received data to WAP-format (WSP) and then forwards it back to the requesting client.

⁸⁹ Ewert, 41

⁹⁰ Zdnet, *Supporting the Wireless Application Protocol (WAP) in Linux*, Boris Kuschel, (www.zdnet.com), (000912)

8.2.3 WAP components

8.2.3.1 WML

WML is a mark-up language, used for presentation on the client side, and is the counterpart for HTML on the web. WML is not based on HTML, instead it is based on *XML* (eXtensible Markup Language). One of the main differences between HTML and XML, is that HTML has a defined tagging language, while XML is a meta-language where you can define your own tags. The legal tags for a document are defined in a *Document Type Definition* (DTD). WML is defined in a DTD specified by WAP forum.⁹¹

When WML is to be transferred over the wireless network it has to be compiled (the code is transformed to binary form). WML-compiled representation, transferred over the net, is quite compact and the needed use of bandwidth and data transmission time is very low.⁹² Another prominent distinction between WML and HTML, is that WML uses the structure of *decks and cards*. A deck consists of several cards, and the cards consist of specific content, to be presented in a browser at the given time. When the client requests a resource, a complete deck is sent in response to the client. The client receives the deck, and holds the whole deck in its primary memory, and as a consequence, navigation between different cards in the same deck will be very fast.

WAP also includes WML-script. It is a scripting language similar to the WWW's counterpart – Java-script. WML-script adds functionality to WAP applications, for example in the form of “validate input” functions.

8.2.3.2 The client

The client is a mobile unit, containing a micro-browser allowing the client device, such as a phone, to read WML content, over the web, through the WAP-stack.

This is how the data communication works:

On request: The client encodes the URL to binary code (WSP request) and then adds needed layers from the WAP protocol stack to the WSP request. The WSP, which is a binary form of a HTTP call, will then be transmitted to the WAP gateway by a mobile network bearer.

Mobile network bearers could be GPRS, SMS, GSM, etc. The WDP (Wireless Datagram Protocol) protocol is the interface between WAP, and the bearer service, containing information about supported bearers.

On response: The mobile unit converts the binary WML code to text when receiving a WSP response from the WAP gateway.

⁹¹ Mobic, *WAP introduction*, (www.mobic.com)

⁹² Mikael Hillborg, *WAP: Mobile Internet*, (Pagina, 1999)

8.2.3.3 The WAP gateway/proxy

The WAP gateway emulates the behaviour of a web browser. The WAP gateway is the bridge between the mobile unit (the client) and the Internet and it allows the phone to communicate over the web. The main mission for the WAP gateway is to convert WSP requests into HTTP calls, and the opposite, to convert HTTP responses into WSP responses.

On *request*, the WAP gateway converts a WSP request into a HTTP call and sends it out on the Internet.

On *response*, the WAP gateway converts the HTTP response from the server to binary code, using the WSP, and transmits it to the client. The gateway encodes WML in to compact binary form in order to minimize the amount of data sent over the network.

The gateway is the major distinction between the WWW-model and the WAP-model. The gateway has two major tasks:

- The first is to convert data between protocols. It converts between the Internet protocol stack and the WAP-protocol stack, and the other way around.
- The second major task is to reduce the size of content sent over the wireless network by compiling code received from the web server, to a matching byte representation.

8.2.3.4 The server

The server is also known as the content server. This server receives HTTP requests from the WAP Gateway on behalf of the user and returns content, according to the request. The server works towards the gateway in the WAP-model, exactly in the same way as it would do towards any node in the WWW-model.

8.2.4 The Internet protocol stack Vs the WAP protocol stack

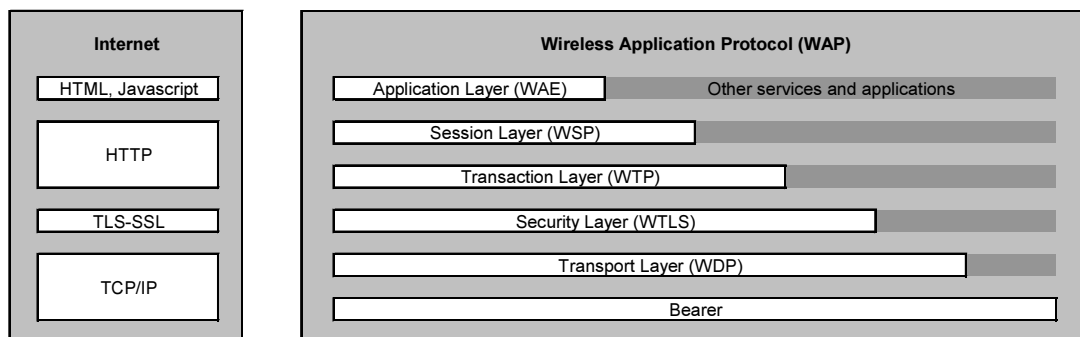


Figure 8-4 The internet protocol stack Vs the WAP protocol stack

8.2.5 The WAP protocol stack

8.2.5.1 WAE – Wireless Application Environment

WAE is a general environment for mobile applications. The main function for WAE is to serve as an environment enabling operators and companies to create services and applications, which can be used by several wireless platforms in a useful and efficient way.

WAE includes a micro browser containing the following functionality:

- WML (Wireless Markup Language)
- WML-script
- WTA (Wireless Telephone Application)
- Content Formats (a number of well defined data formats, which includes images, a telephone book, and calendar information).

8.2.5.2 WSP – Wireless Session Protocol

WSP is the application layer in WAP, with an interface for two different kinds of session services: connection oriented and connectionless session service. So far, WSP only handles services adjusted for browsing (WSP/B).

WSP/B has following functionality:

- HTTP/1.1 functionality and semantic, designed for compressed wireless traffic.
- Suspend /resume function of sessions.
- A service for reliable and non-reliable data transactions.
- Mechanisms for negotiation of protocol functions.
- Long-lived session approvals.

The protocols in the WAP environment are optimised for low bandwidth and delays. WSP/B is designed to enable a WAP Proxy to connect a WAP client with a HTTP server.

8.2.5.3 WTP – Wireless Transaction Protocol

WTP uses a connection less datagram service in order to create a transaction-oriented protocol for mobile clients. The following parts are included in WTP:

- Three classes of transaction services:
 - Unreliable one way requests
 - Reliable one way requests
 - Reliable two way requests/response transactions.

- A possibility to enable secure connections by using triggers. The user will then manually confirm that a message has been delivered.
- A possibility of extra information: “out of band”.
- Conversion of PDUs (Protocol Data Units) to reduce the number of messages being sent.
- Asynchrony transactions.

8.2.5.4 WTLS – Wireless Transport Layer Security

This is a security protocol based on the standard “TLS” – Transport Layer Security, former known as SSL – Secure Sockets Layer. WTLS is designed to be used together with the transport protocols in WAP and is optimised for wireless communication with limited bandwidth. The following components are parts of WTLS:

- Integrity – WTLS guarantees that data transmitted to the receiver will remain unchanged.
- Security – a guarantee ensuring that the data transmitted will be coded in such a way that it will be protected for external parts.
- Authentication – functions enabling users, clients, and servers to prove their identity.
- Protection against “denial of service”. WTLS contains various functions designed “not to accept unverified data”. This will make it much more difficult for hackers to attack the systems and it will also protect other higher layers in the protocol stack.

An application can autonomously determine which security functions in WTLS that should be activated, depending on the requirements of the particular system.

8.2.5.5 WDP – Wireless Datagram Protocol

WDP is the transport layer in WAP. It is the interface between the WAP components and the mobile network bearer. WDP offers a transparent communication service for the higher layers, looking the same no matter which bearer being used. Practically, this means that the higher layers can run individually and independent of the bearing technology.

8.2.6 What is a protocol?

A *protocol* is a set of rules facilitating the exchange of data between two nodes⁹³. Protocols are handled by software related to the network, and work as a kind of pre-communication, insuring that everything is in order before data are sent.⁹⁴

⁹³ A device connected to a network, like: servers, computers, and peripheral devices.

⁹⁴ H. L. Capron, *Computers, Tools for an information age*, (USA: Addison Wesley, 1997), 171

8.2.7 Packets and TCP/IP

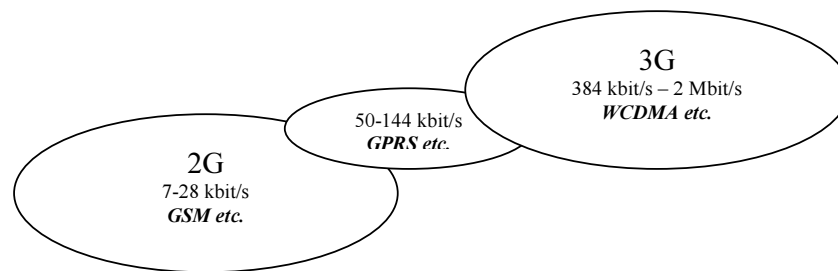
When a message is to be sent to another computer, it must be divided up into *packets*, each labelled with a destination address. Each packet is sent and routed individually, in the direction of its destination, and will eventually, at the end of the journey, be reconstituted into the original message. A packet can travel in a variety of paths; the chosen path does not matter as long as the packet reaches its destination.

The software taking care of the packets in the WWW-model, is called *TCP/IP* (Transmission Control Protocol/Internet Protocol). TCP does the packing and reassembling part of the message, while IP handles the addressing part.⁹⁵ TCP/IP is probably the most important protocol standard in the computer Industry; it permits any computer to communicate with the Internet.

8.2.8 A glance at 3G

A big difference between the first-generation systems for mobile telephony, and the most used mobile standards of today, is that the first-generation system was analogue. The second-generation systems (2G), used today, were launched in Europe in the beginning of 1990, and are digital. GSM is the leading standard of the second-generation systems, both in terms of size of the distribution area, and in terms of numbers of subscribers. Now, the third-generation (3G) system stands in front of the door.

The fast growing need of bandwidth for “non-speech” services like e-mail, mobile access to WWW, etc, is becoming more and more evident. This motivates the operators to open up the door and initialise the conversion from the 2G standard and to the new 3G standard. An essential difference between 2G and 3G, is that 3G is optimised for packet switched data. Packet switched data is cheaper, and only requires ten percent of the capacity needed for internet traffic in nets with the traditional circuit switched technique.



In Europe, the next step for GSM, is its packet switched variant - GPRS (General Packet Radio Service). This conversion, from GSM to GPRS will double the transmission rate, and is a big and important step towards the third generation systems for mobile telephony.

WCDMA (Wideband Code Division Multiple Access) is a truly member of the third generation system for mobile telephony, and will probably be the most common

⁹⁵ Capron, 197

system for future mobile nets. WCDMA will have a general transition rate of approximately 384 Kbit/s or 2Mbit/s on “hot spots”, which is a major difference from the today’s systems (having only 7-28 Kbit/s transition rate). 85 percent of the operators worldwide have chosen this standard for the evolution from 2G to 3G.⁹⁶

⁹⁶Bertil Edin, ”Datapakets i mobilnäten”, *Kontakten*, nr 8, (010425)

8.3 Action research study: Description of GSM Pro

In-house material about the product GSM Pro, and its features.

Technical overview of GSM Pro Server



The GSM Pro Server is the central processing unit of the GSM Pro concept. Each server consists of two main parts – the Switch Node (SN), and the Administrative Node (AN). One Administrative Node can support several Switch Nodes.

The SN as well as the AN computer components are based on new robust CompactPCI technology offering very high capacity of each single component in spite of their small dimensions.

Combined GSM and PMR communications

GSM Pro is a new Ericsson concept that offers ordinary GSM users a unique opportunity to combine the advantages of GSM with PMR facilities such as group calls, push-to-talk operation, shock and water resistant terminals and dispatch controlled communications.

The concept includes products purely added on to existing GSM networks which means that they don't intrude upon the ordinary GSM network equipment.

With the GSM Pro concept, organisations that today use both GSM mobile phones and PMR terminals have the opportunity to combine the functions in the GSM Pro concept.

SN – interface to GSM network

The Switch Node (SN) provides an interface to the GSM/MSC and the necessary switching and database hardware and software. It performs the GSM Pro end-user typical PMR voice functions as Group Calls.

With several Switch Nodes, the capacity of a GSM Pro Server allows gradual increase without having to build new interfaces to the support systems as OSS/NMS and Customer Care. It also allows the nodes to be distributed geographically in order to cut down transmission costs.

The connection between the SN and the MSC is performed via E1 transmission lines. The lines are complemented with SS7 ISUP links for call control. Up to 12 E1 lines can be connected depending on the SN configuration. An SN cabinet may contain two switch nodes.

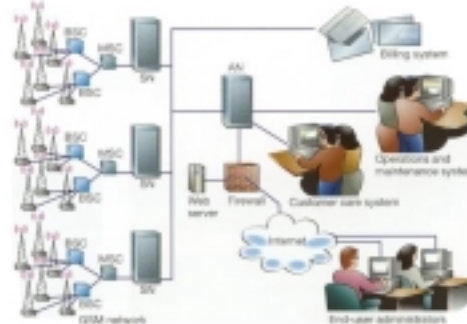
The SN interfaces to both the billing system and the AN via an IP network. Communication with the billing system consists of Call Detail Records (CDR) and is encoded using standard ASN.1/BER format and uploaded using FTP.

Communication with the AN consists of configuration information, database updates and alarms.

AN for all administration

The Administrative Node (AN) executes the administrative functions and interfaces to the OSS/NMS system, the customer care system and the end-user administrators. It also contains the central database of the subscribers involved and information for controlling the end-user management. The database is distributed automatically to the correct SN when changes are made. Since the OSS/NMS and

the customer care system interfaces to the AN, every GSM Pro Server can be managed as one unit even if it is distributed geographically.



The GSM Pro Server can be managed as one unit even if the Switch Node consists of several units distributed geographically.

Acronyms and Abbreviations

AN	Administrative Node
ASN.1/BER	Abstract Syntax Notation (1) / Basic Encoding Rule
CDR	Call Detail Records
E1	2 MHz (G. 703)
FTP	File Transfer Protocol
GSM	Global System for Mobile Communications
ISUP	ISDN User Part
IP	Internet Protocol
MSC	Mobile Switching Centre
NMS	Network Management System
OSS	Operation Support System
PCI	Peripheral Component Interconnect
PMR	Professional (Private) Mobile Radio
SN	Switch Node
SS7	Signalling System No. 7

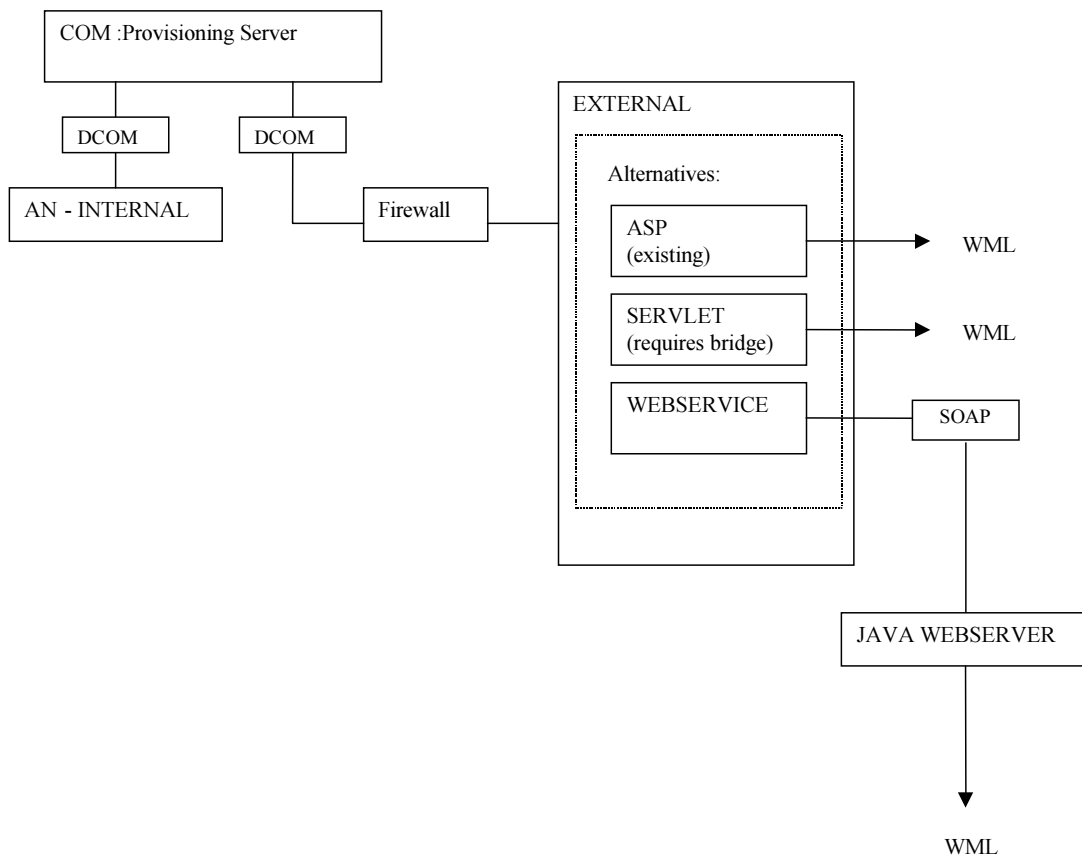
Technical Data

- SN to MSC communications: Max 12 E1 lines and 6 SS7 links
- Power supply: -48 VDC, max 1200 W/node
- Rack dimensions (HxWxD): 1800 x 600 x 500 mm
- Operating temperature: 0° C to +40° C
- Further characteristics: CE approved

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8.4 Action research study: Different WAP solutions



8.5 Graphical user interface development: Usability rules

We have chosen to present a list of checkpoints from Johan Hjelm's book, *Designing Wireless Information Services*. According to him, the list presented below, recapitulates the basic rules for mobile web design.⁹⁷

Literature about usability design often contains lists of checkpoints, like the one below, in order to help developers to redesign existing web-pages, or create new ones, for mobile access. This is one example of such a list.

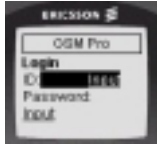














The rules are the following:

1. *Redesign your images*
2. *Use special encoding languages instead of images*
3. *Use semantic elements for semantics*
4. *Be careful of tables*
5. *Avoid frames*
6. *Use <OBJECT>*
7. *Do not use methods that create content on the client*
8. *Separate structural and presentation markup*
9. *Use style sheets for presentation*
10. *Use relative units*
11. *Provide variants and alternatives*
12. *Use the name and id attributes*
13. *Help the user find the information*
14. *Simplify navigation in all representations*
15. *Provide for searching*
16. *Make links clear*
17. *Facilitate navigation by providing ordered lists*
18. *Use metadata*
19. *Validate your markup*
20. *Create sections in the content (which make pages fit into cards)*
21. *Code forms correctly*
22. *Code correctly*
23. *K.I.S.S (Keep It Simple, Stupid)*
24. *Use color carefully*
25. *Avoid animations*
26. *Remember that rich presentations can be turned off*
27. *Enable keyboard operation*
28. *Show the language*
29. *Spell out abbreviations*
30. *Make documents easy to read and simple to understand*
31. *Be credible*
32. *Design device-independent events*

⁹⁷ Hjelm, 127

8.6 Action-research study: User interfaces

User interfaces for the WAP application designed for GSM Pro.

 <p>Input Id, password and press next.</p>	 <p>Input search criteria and press next, or just press next to view then ten first available groups.</p>	 <p>Choose group to edit by following a link.</p>	
 <p>Choose "Add member" from the menu.</p>	 <p>Input search criteria and press next, or just press next to view the ten first available members.</p>	 <p>Choose member to add.</p>	 <p>Go back to menu (the options "Back to Menu" and "Logout" is placed at the bottom of each page.</p>
 <p>Choose "Delete member" from the menu.</p>	 <p>Choose member to delete.</p>	 <p>Go back to menu.</p>	
 <p>Choose "Member list" from the menu.</p>	 <p>Go back to menu.</p>		
 <p>Choose "Change Group" from the menu to go back to the "Find groups" view.</p>		 <p>Choose "Logout" to abandon the session.</p>	 <p>Follow link to login.</p>

8.7 List of abbreviations

AN	Administrative Node
ASP	Active Server Pages
Back-end code	Code executed on the server
CGI	Common Gateway Interface
COM	Component Object Model
CPUG	Closed PMR User Group
DCOM	Distributed Component Object Model
Front-end code	Code executed on the client
GPRS	General Packet Radio Service
GPS	Global Positioning System.
GSM	Global System for Mobile Communication
GUI	Graphical User Interface
HDML	Handheld Device Markup Language
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
IT	Information technology
ITTP	Intelligent Terminal Transfer Protocol
ITU	International Telecommunication Union
JSP	Java Server Pages
NBS	Narrow Band Sockets
OSI	Open System Interconnection
PC	Personal Computer
PMR	Personal Mobile Radio
SOAP	Simple Object Access Protocol
SSL	Secure Sockets Layer
TLS	Transport Layer Security
TTML	Tagged Text Markup Language
UMTS	Universal Mobile Telecommunications System
URL	Unified Resource Locator
WAP	Wireless Application Protocol
WDP	Wireless Datagram Protocol
WML	Wireless Markup Language
WMLS	Wireless Markup Language Script
VoIP	Voice over Internet Protocol
WSP	Wireless Session Protocol
WTLS	Wireless Transport Layer Security
WTP	Wireless Transport Protocol
WWW	World Wide Web
XML	Extensible Markup Language