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Abstract

The diversity of mobile Internet services and devices is increasing. New services will reach a growing number of users, which means that user heterogeneity will increase. Providing device adaptation and personalised services is a major challenge when moving towards a device-independent web.

The WAP-UAPROF project (November 1999 – October 2001) was used to design and implement an adaptation proxy with capabilities for web and media conversion. Personalisation and communication tools were also implemented. The service was evaluated with 81 users in two separate field trials in 2000 and 2001. Profiles of mobile users were drawn from the results.

Free mobile access to web content brought WAP to a more personal level. With greater content, users shifted towards services that answered their personal needs. There was also a clear need for interactive services, where users could interact and communicate with other people. Context-wise, the field trial demonstrated that much of the use took place at home in the evening, rather than on the move.

The user studies were complemented with two rounds of interviews with service providers. The service providers regarded the conversion proxy as a viable approach to providing access to web services for mobile customers and employees.

The conversion and adaptation proxy server is a working solution to give WAP clients access to web services and to adapt WAP content for different devices. The results of the user studies stress the fact that mobile devices are above all personal communication devices. The most popular services included personal content and services, which provided users with new ways of communicating with other people. Targeted services, which coincide with the users' lifestyles, are needed to serve the interests of a growing diversity of users.

Preface

This publication contains the results and experiences of the two-year project "Adaptation of Internet services to mobile terminals - WAP-UAPROF" which took place between November 1999 and October 2001. This project was part of the "USIX User-Oriented Information Technology" research programme run by the National Technology Agency of Finland (Tekes).

Besides Tekes and VTT Information Technology, a further four companies - Alma Media, Nokia, Radiolinja and Teamware Interactive - financed the project. Each of the co-operation partners was represented in the project management group. The project also comprised a technical support group including participants from the companies involved as well as the project group. Both the management group and the technical support group made a major contribution towards ensuring the success of the project.

The project team at VTT Information Technology included Matti Aaltonen, Matti Alatalo, Tapio Hiltunen, Eija Kaasinen, Eija-Liisa Kasesniemi, Juha Kolari, Minna Kulju, Timo Laakko (project manager), Juha Leppänen, Olli Pihlajamaa and Raisa Suihkonen. In addition to technical experts, the multidisciplinary project team included experts on human-computer interaction, cultural research, psychology and commercial science. Also, several other individuals at VTT Information Technology and the participating companies have contributed to the results of the project. We also wish to acknowledge all the participants of the user trials, who gave us their time and insight. They were essential to the project.

The project was used to design and implement a web conversion and adaptation proxy, as well as personalisation and communication tools. A human-centred design approach was adopted throughout the project: the acceptance of the users and service providers guided the design process from the very beginning. The services developed were evaluated in large scale field trials, resulting in outlines to meet the challenges to the usability of services and adaptation from one context of use to another.

Contents

List of symbols

CC/PP   Composite Capability and Preference Profiles [CC/PP]

HTML   Hypertext Markup Language [HTML]

HTTP   Hypertext Transfer Protocol [RFC2068]

UAProf   User Agent Profile [UAPROF]

UI   User Interface

W3C   World Wide Web Consortium

WAE   Wireless Application Environment [WAEO]

WAP   Wireless Application Protocol

WBMP   Wireless BitMaP

WML   Wireless Markup Language [WML]

WSP   Wireless Session Protocol

XHTML   Extensible HyperText Markup Language [XHTML]

XML   Extensible Markup Language [XML]

XSLT   Extensible Stylesheet Language Transformations [XSLT]

1. Introduction

1.1. Background

The rapid growth of Web applications has led to a situation where companies and individuals rely more and more on material that is available on the Internet and intranets. The next step is for mobile users to gain access to the Web in a larger extent as well. Even before the advent of WAP (Wireless Application Protocol), some simple interactive services have been available to mobile phone users. These services are based on the GSM short message service (SMS) and include schedules, news, sport results, weather forecasts and so on. Although the available SMS-based services are rather awkward to use, they have become quite popular. This indicates a need for additional mobile Web applications. Access itself will probably be the killer application for the mobile Internet. [KAA00]

WAP provides an extensible environment for application development for mobile communication devices [WAEO]. It makes it possible to provide markup-language based services for different mobile devices equipped with suitable browsers. Furthermore, WAP defines protocols and run-time environments needed in delivering new and existing Internet services to mobile users.

Current discussions about mobile Internet often start by blaming WAP as a total disaster. It seems that service designers would rather forget this embarrassing failure and start all over again with 3rd generation mobile networks and devices. But will things get better just with faster networks and multimedia? There is more to learn about the first user experiences with mobile Internet on phones than just to increase speed and decrease the price.

Ramsay and Nielsen [RAM00] state in their study that WAP is not web: the kinds of user interface solutions that we are used to in Web world do not always work on small mobile devices. However, mobile Web cannot be an entity on its own right, either. In the future the same user may have several mobile and fixed network devices from which (s) he selects the most appropriate for the current or planned context of use. The different devices should be able to communicate with each other and access same data [OLS98]. It would be beneficial to be able

to use exactly the same services on these different devices and even to change the device in the middle of a usage session.

How should service providers create services for the growing variety of mobile clients? Simultaneously with the ongoing international specification work of WAP, we have studied two different approaches for bringing Internet services to mobile devices [KAA00, KAA01]. The mobile-aware approach is to design and implement totally new services that are specially designed for mobile users. A more generic approach is to develop techniques with which current Internet services can be converted transparently and in real time, and be suitable for mobile users. We have implemented and evaluated both kinds of solutions.

Figure 1. Adaptation of Internet services to different terminals.

1.2.   The objectives of the project

The project studied the adaptation and implementation concepts of the Internet/Web services for mobile environments. The project aimed to develop a system that can be used to adapt Web services and applications to the growing variety of WAP phones and terminals (Figure 1). The adaptation took into account the terminal and network capabilities and properties, as well as user preferences. In that, the User Agent Profile (UAProf) information may be utilized by the client terminal/browser, proxies, and application servers in the content and terminal adaptation and personalisation. The project also designed and implemented applications and services which utilise personal multimedia. The conversion and adaptation service as well as the example applications were evaluated in user trials.

Usability and utility of the services were the key issues in the project. The design process consisted of iterative design and user evaluation phases. With the methods of human-centred design, the project aimed to ensure that the realised solutions fulfilled the requirements of both the mobile users and the service providers.

The initial goals and requirements included the following:

- To study the adaptation and implementation concepts of the Internet/Web services for mobile environments. The project aimed to develop a system that can be used to adapt Web services and applications to the different kinds of WAP phones and terminals which may become available in the future.

- To develop and finalise new examples of adaptable services. The adaptation must take into account the terminal and network capabilities and properties, operational environment and user preferences.

With the methods of human-centred design, the project aimed to ensure that the realised solutions fulfilled the requirements of the mobile users and service providers.

1.3. Overview

This document summarises the results and experiences gathered from the WAP-UAPROF project. In the first instance, chapter 2 provides an introduction to aspects of a device independent web as well as usability issues related to this. Chapter 3 describes our approach to a device independent web and WAP access to web services. Chapter 4 describes the conversion and adaptation proxy server in more details. Chapters 5 to 11 describe and analyse the set-up and results of the user trials. Chapter 12 highlights the points of views of the service providers. Finally, we draw our conclusions in chapter 13 and point out some directions for future work in chapter 14.

2. Towards a device-independent web

The diversity of mobile Internet services and devices is increasing. When the Internet becomes available on mobile devices, the users can gain access to it almost anytime and anywhere. New services will reach a growing number of users, which means that user heterogeneity will increase. Providing device adaptation and personalised services is a major challenge when moving towards a device-independent web.

The main user interface restrictions of mobile devices are: small screen, limited input techniques, limited amount of memory, and slow network connections. Today, the users try to overcome these problems by avoiding complex pages. A number of service providers maintain separate and lighter versions of their web pages for mobile users.

2.1.   Mobile services

In his Alertbox (October 1999), Jakob Nielsen defines three levels of sophistication on the Internet [NIE99]:

- Specialised applications that are optimised to the best possible user interface to a set of advanced features. These applications will not necessarily run on older browser versions.

- Traditional web pages that are highly standards-compliant and will work on two-year-old browsers.

- Narrowly focused small devices that cannot support the full range of features because of their small screen or low bandwidth.

There is a need for both mobile-transparent and mobile-aware services (Figure 2). Mobile-aware services are specially designed for mobile users. Often, these services are designed for use at a certain place, e.g. a conference information system or a location-aware tourist information service. The mobile-aware service may be accompanied by a web service, but both services have their own functions.

Most web services are such, however, that people need to access them at any time and anywhere. Users want to access the same services with different devices depending on their current context of use. These services should be mobile-transparent to the user, i.e. they should adapt their contents and presentation according to the device being used, network characteristics and user preferences. It is beneficial to maintain the look and feel of the service as much as possible because familiarity improves usability.

In addition, there is demand for distributed services where a mobile service complements a fixed network service or vice versa.
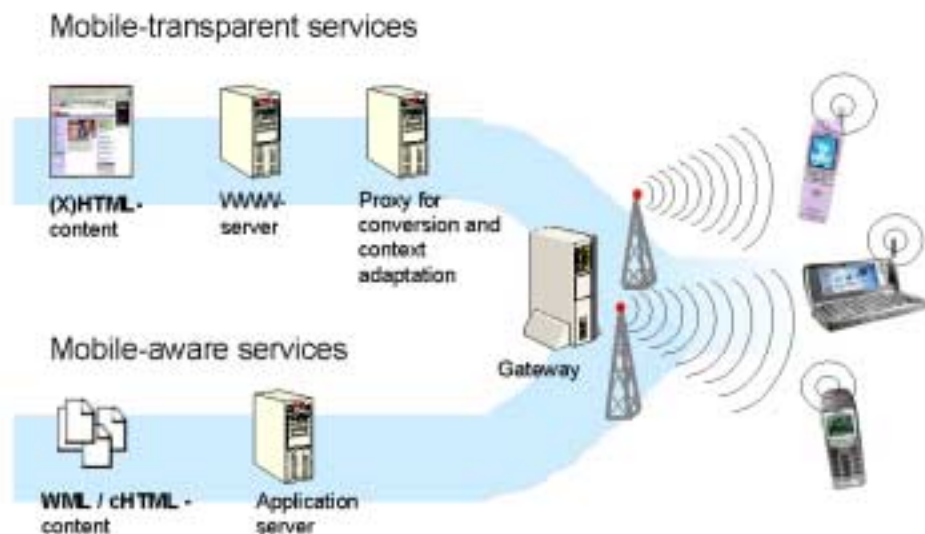
Figure 2. Both a mobile-transparent and mobile-aware service are needed, as well as solutions where one approach complements the other.

The World Wide Web consortium (W3C) has specified usability guidelines for web design, such as HTML 4.0 Guidelines for Mobile Access [W3C99a] and Web Content Accessibility Guidelines [W3C99b]. The guidelines point out that anybody can experience accessibility problems, depending on his/her context of use and the terminal being used. That is why these two W3C guidelines are similar in many respects. The key recommendations include separating content and presentation, providing alternatives for auditory and visual content, providing context and orientation information and avoiding excess content.

In our laboratory tests, we found that the W3C guidelines can also be utilised in designing convertible sites. Our HTML/WML conversion proxy could correctly convert most of the sites that were designed according to these guidelines [KAA00].

2.2. WAP devices

Symbian has classified future mobile devices into three categories: communicators, smartphones and feature phones [Allin01]. Current WAP devices include all of the above categories. In addition to the display and input methods, the devices also vary according to accepted content types and network connections.

An important difference in WAP devices is also the functionality of the browser. WAP browsers differ in at least the following characteristics:

- The use of soft keys
- Availability of Back/Forward
- Left/right navigation on the screen
- Displaying the title of the card
- Support for wizards
- Location of initial focus on a card
- Support for tables
- Supported image formats
- Layout on the screen
- Preferred menu presentation
- Availability of short cuts
- Preferred presentation of forms

WAP is an open standard, available for all vendors. That is why the variety of devices and browsers poses a big challenge in designing usable WAP services. The designer can create a generic application by avoiding all browser-specific

features. However, a better approach is to adapt the application for specific browsers, in which case the designer can utilise specific browser features to overcome usability problems or to improve usability.

In their WAP study [RAM00], Marc Ramsay and Jakob Nielsen describe a situation where two users access the same site with different phones. One of the users describes the site as "fantastic", and the other says that the site makes him feel "aggrieved". The latter user could see the index of a restaurant guide but every time he tried to access the information itself, he got the message "wrong address". These kinds of problems arise when designers have omitted to take into account the different capabilities of the WAP devices and the different interpretations of WML code on the browsers.

Different from WAP, the Japanese i-mode is a closed specification. The operator (NTT DoCoMo) [NTT01] is both in charge of delivering the devices and offering the services. The user interfaces of the different phones all follow the same specifications, and the operator also selects the services to be provided. In this approach, service providers do not need to worry about the adaptation of services.

Recently, more attention has been paid to the consistency of WAP browsers. In May 2001, GSM Association has published M-Services feature guidelines for mobile phones [GSM01]. The aim of these guidelines is to ensure that service providers can depend to a certain extent on a consistent set of features and services in mobile handsets.

The M-Services guidelines propose two alternative HMI (Human-Machine Interface) models in the browser, depending on the keypad layout of the phone. One of the models resembles the current Openwave browsers, whereas the other resembles the Nokia and Ericsson models. Other device characteristics recommended by the M-Services guidelines include for example a dedicated key to access M-Services, four navi keys and a specific alert indicator (status bar, icon, etc.) for WAP push alerts.

2.3. WAP usability

Usability is a measure of the quality of a system from the user's point of view. Usability defines whether the system solves the right problems from the user's point of view (i.e. includes the right functionality), and whether the system solves the problems in the right way (i.e. is easy to use). Usability design implies learning to know the users and understanding their needs so that the user's point of view is properly taken into account in the design.

Usability has multiple components. E.g., it is defined by International Organisation for Standardization (ISO) as "The effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments". [ISO9241]

- *Effectiveness* defines whether the system includes the right features from the user's point of view.

- *Efficiency* defines how quick and easy the system is from the users point of view.

- *Satisfaction* defines that the system should be pleasant to use, so that the users are subjectively satisfied when using it, i.e. that they like it.

The *effectiveness* problems in WAP services are often related to the limited selection of available services, and the limited contents of these services. There are no general rules for what kind of content mobile users will need. Mobile services are often built as subsets of fixed network services, picking up a small selection of contents based on assumptions regarding what kind of services mobile users will need. The process often leads to a general content that can also probably be accessed elsewhere, and more easily than with the WAP service.

The main *efficiency* problems in WAP Services are related to the restrictions of mobile devices, browsers and networks. In current WAP networks, the main efficiency problem is the time required to establish a connection to the service. On a small screen, only a limited amount of information can be displayed at a time. Because of memory restrictions, the device can only receive a limited

amount of data at a time. When accessing the service, the user has to scroll the screen and wait for new downloads every now and then. Since the information has to be served to the user in "small portions", the services have to be constructed based on limitations rather than natural classification. As a result, the services often include artificial classifications, thus causing problems to the user. For instance, the services are often divided into categories such as "Utilities", "Tools" and "Entertainment", giving the user little idea which category the service he or she is seeking belongs to. The navigation efficiency in the services can be improved by trying to make the items that the user is most likely to request the easiest to access. The user should get good navigation support, including feedback in the page header on where he/she currently is in the service. There should also be easy access to back and forward, as well as to "safe havens" in the service.

User *satisfaction* is based on the total usage experience, ease of use and utility (Figure 3). Mobile users do not usually browse around but need the information or service quickly. Compared to fixed network users, mobile users need services that are faster and easier to use on their much more modest devices. These user requirements are not easy to fulfil.

Figure 3. User satisfaction can be achieved with easy-to-use and useful services.

2.4. WAP usability design guidelines

The first WAP usability design guidelines were device specific, and did not include advice on how to ensure that the service would work on other platforms as well. Later on, as more devices were launched onto the market, a concept of designing generic WAP applications was published in WAP Forum. The idea was to give instructions on designing minimal services that would work with any device, even the most modest one. However, it was soon admitted that the variety of the devices available was so big that these kind of general guidelines did not work.

Today, the guidelines under discussion in WAP Forum [WAPF] emphasise that generic applications are a good solution when it is not possible to test the application on different platforms. The most usable services utilise the unique features of each phone and browser.

Phone and browser manufacturers provide their own guidelines for specific phone models. The phone manufacturers Ericsson and Nokia have published separate guidelines for almost each one of their models [Ericsson00, Ericsson01, Nokia01]. Openwave provides guidelines which advise adapting applications for phones using Openwave browser, Nokia browser or Mitsubishi Trium browser [Openw01a].

All the guidelines for WAP applications emphasise simplicity, navigation support and consistency. With WAP phones, users are typically not browsing but quickly looking for specific information. Text entry is slow and cumbersome, so it should be avoided or minimised. Often, text entry can be replaced with, for example, selection lists. Unnecessary user errors should be avoided and in the case of an error, the user should be told what the problem is and how he/she could solve it. The WAP design guidelines do not presume that the service to be designed already exists in the Web. Thus the guidelines concentrate on giving advice in creating a service from scratch, rather than adapting existing services.

From the service providers' point of view, the variety of the different design guidelines presents a number of problems. The aim of the service provider is to serve all customers, irrespective of their phone model. In practice however, it is impossible to take into account all kinds of devices. Usually, the service

provider only takes into account the most common devices used on the target market. This means that those users whose phone models are less common will only get the "minimum service", if any at all, whereas other users may get a more usable service, i.e. one that is specially adapted for their phone. In addition, when new phone models are launched on the market, the service provider has to adapt the service accordingly.

2.5.   Device adaptation

XML (eXtensible Markup Language) is a meta language for describing other markup languages. As a meta language, XML makes it possible to define customised markup languages for different purposes [XML]. For instance, XHTML 1.0 [XHTML] is a reformulation of HTML 4 in XML 1.0. XHTML includes better support for separating content and presentation, and it provides new ways of having alternative content formats. Some usability design guidelines for XHTML are already available. For example, Johan Hjelm [HJE00] has defined 32 detailed rules for mobile web design utilising the possibilities of XHTML.

XHTML is also modular [XHTMLM] and thus easily extendable. As a consequence, browsers have to support several different modules. In particular, XHTML Mobile Profile [XHTMLMP] (a part of WAP 2 specifications) is based on the modularization of XHTML and is an authoring language for WAP2 services and applications. It is a strict superset of the XHTML Basic document type [XHTMLB]. The WML 2.0 document type extends XHTML Mobile Profile. WML 2.0 includes WML 1.x compatibility and other extensions. XHTML Mobile Profile is a compact core module, which is to be supported by most of the browsers. The WML documents written using earlier WML versions (WML 1.x) can be transformed into WML 2 format. WAP 2 also includes style sheets (WCSS) [WCSS] targeted for XHTML Mobile Profile and WML 2 documents.

Device adaptation could be based on the available information regarding the client device (browser), the network used, user preferences etc. All this information should be available to the software component that performs the

adaptation. In that, WAP User Agent Profile (UAProf) (see chapter 4.1) specification is targeted to provide a basis for the adaptation.

W3C has recently started a "Device Independent Web" activity [W3C01] working towards seamless Web access and authoring. The motivation of the activity is that content authors can no longer afford to develop a content that is targeted for use via a single access mechanism only. There is a need for common guidelines on how to design and provide multiplatform web services.

3. Our approach to a device independent web

We implemented a conversion and adaptation proxy server which converts and adapts web services for different WAP client terminals. Figure 4 illustrates the overall architecture and components of our demonstration system. The users of WAP devices access the system via the operator (Radiolinja) gateway. Both web and WAP access go through the proxy server. The proxy also hosted some example services for the trial, as well as personalisation tools and user data.
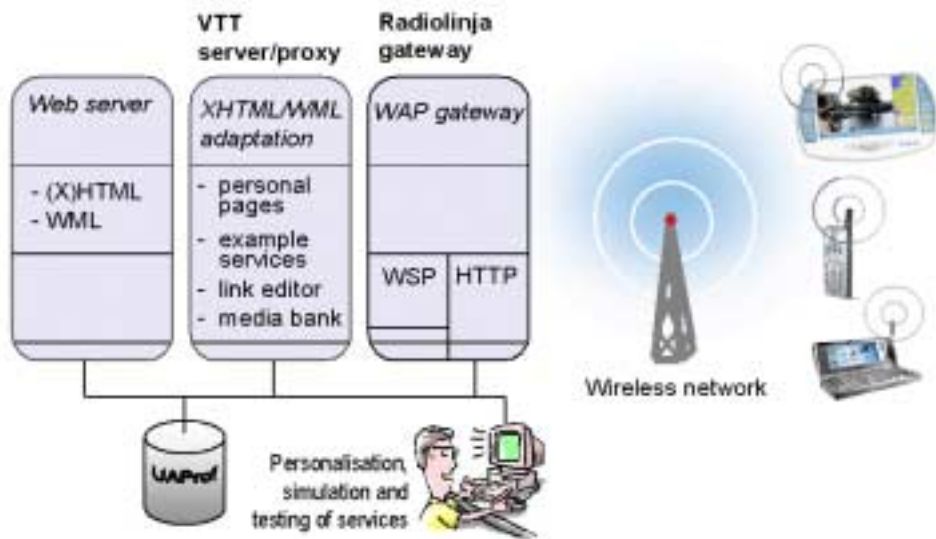
Figure 4. The demonstration system's overall architecture.

The overall environment included:

- External WAP gateway (by Radiolinja)
- WAP adaptation proxy/server (cf. chapter 4)
- A link editor application (chapter 5.4.1)
- A media bank application
- Several example services such as a message board and poll (chapter 5.4.2)
- Personal pages of the users that could be edited by the link editor with WML or HTML browsers (chapter 5.4)

The system performs the (X)HTML to WML conversion whenever needed, i.e. when the content (static or dynamic) is in HTML or XHTML format. The adaptation proxy communicates via HTTP protocol with other proxies and servers, and can access WML and (X)HTML applications stored in external HTTP Web servers.

The link editor is located on the same server as the adaptation proxy module, and it is used in conjunction with the proxy. In the field trial set up, the other example services were located on different Web servers. For example, the message board and poll services were located in a Teamware site.

4. WAP proxy - adaptation of services

Most of the functionality of ordinary web pages can be made available to mobile devices. For instance, the existing WAP portals provide examples regarding how this can be done. In the HTML world, the application developer may assume that the user agent has a large colour display, a pointer and an alphanumeric keyboard. In the mobile world however, the user agent capabilities vary and are generally very modest when compared to desktop browsers. The display sizes and capabilities vary from the small text displays of mobile phones to the moderate colour screens of PDA´s. Also, a pointer is rare and the text input may be elaborate. The mobile application should be tailored to the particular device to guarantee good quality. The WAP adaptation proxy tries to automatically adapt a document to a device that it was not originally designed for.

Jakob Nielsen [NIE99] gives a list of principles on how to offer the same service with multiple interfaces. It is important that the different interfaces feel like variations of a single system even though they have different designs:

- All system data should be the same across interfaces, even if all information is not shown on all interfaces.

- All user information should be preserved across interfaces. The changes made through one interface should be visible through another.

- Unified login, user identification and user profile should apply to all UIs

- All UIs should provide the same functionality and side effects of commands, even if some specific features are eliminated in some versions.

It is not easy to decide what features should be preserved in which versions. A graceful degradation always gives users the features that they really need. This requires careful task analysis in real contexts of use.

Consistency is a commonly accepted but sometimes problematic design goal. In the usability design of multi-platform web services, the question of whether the site should look the same on all platforms or whether it should be changed to make use of the idiosyncrasies of a particular environment must be considered. [KET00]

The adaptation may be based on the properties of the requesting user agent, the network used, user preferences, or configuration parameters of the system performing the adaptation.

4.1.   User Agent Profiles

The WAP specification defines the User Agent Profile (UAProf) [UAPROF] that will be used to transmit information about the client. It uses the W3C CC/PP (Composite Capabilities/Preference Profiles) generic framework [CC/PP]. WAP UAProf includes device hardware and software characteristics as well as application and user preferences. Current definition of the UAProf includes over 50 parameters – a major adaptation challenge for service designers. Based on the UAProf attributes, the services can adapt the contents and the presentation for each client. Typically, UAProf is a URI (Uniform Resource Identifier) reference to a shared set of preference data stored on a repository on behalf of all similar devices.

UAProf includes a Default description block, which is used for default characteristics, typically common to a group of devices or user agents across multiple profiles. Each parameter in UAProf is associated with one of three resolution rules that define whether the parameter can be changed during a session, as well as whether the parameter has one or several attributes. The profile can be enhanced to describe additional personal preferences, characteristics of other user agents (e.g., email software) or characteristics of hardware extensions.

 The profile is not yet in use in current browsers. That is why the content and device adaptation could not directly be based on the profile, but merely on identifying the client browser and knowing the properties of the browsers in use (cf. chapter 4.4).

4.2. Document type conversion and content adaptation

The HTML (or XHTML) to WML conversion consists of two main tasks: dividing the document into parts that may reasonably be viewed on a display of the target device, and converting the document type to the markup language supported by the target device. The conversion should have knowledge about the target device, such as display size, supported image formats, and the markup language support.
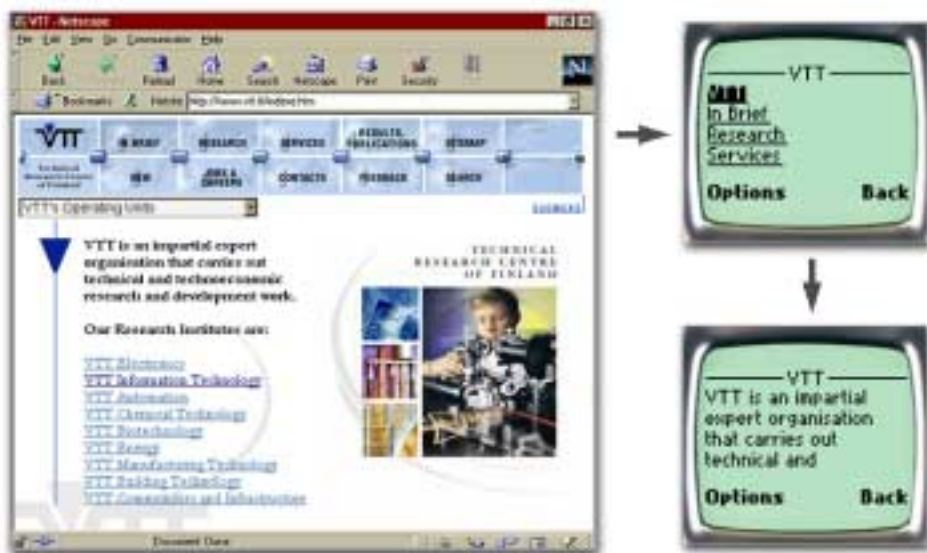
Figure 5. HTML/WML conversion.

The layout of an HTML page must be modified, and images are either discarded or simplified. Most HTML pages are useful even without images, and the layout may be mimicked by the suitable organisation of WML cards. The danger is that the user may not find the desired information even though it is somewhere in the card set. The division into cards makes the presentation simpler, but the cards do not generally render the information unavailable (Figure 5). The practice has confirmed the usefulness of converted HTML pages.

The function of the adaptation can be tuned by several configuration parameters (cf. chapter 4.4). For instance, HTML tables can be transformed into WML tables, hierarchical lists or linear lists on the basis of configuration parameter values (tableListMin, tableTreeMin, ...). Many of the parameter values can be determined from the UAProf parameters (cf. chapter 4.1) of the requesting device. A configuration parameter may also have a direct correspondence with a UAProf parameter (such as wmlDeckSize).

The difficult elements are those that require large space for proper presentation, and those that use spatial arrangement to express hierarchical structure. The HTML table is used for both of these purposes. An example of a table usage that requires a large space is a timetable. The common use of HTML tables is for laying out the content. Each table cell is treated like a small HTML document and it may contain nested layout tables. This structures the HTML page hierarchically. The frames are also used for layout purposes, but their conversion is different because the content of frames is not available during the conversion of the frame set.

Optimally, the conversion should locate logical entities that fit in the target display, convert them, and order them in a way that resembles the structure of the original document. To achieve this, the conversion should recognise the intentions of the author and categorise the elements accordingly. The categories could be, for example, "site menu", "lay-out table", and a "table header row". This is easy to a human expert, but automating this procedure properly would probably require artificial intelligence techniques. Currently, only simple heuristics are used. It is also not always clear how the spatial structure of an HTML document should be expressed as the interlinking of the derived parts.

The conversion must ensure that the user has access to all content that the user agent in question can present. The information should be delivered even if the presentation format is compromised. In the future, the personal profiling of the conversion will enable the user to reject parts of the content, such as images.

The quality of the conversion depends strongly on the authoring style of the source HTML. Ordinary HTML does not pay much attention to accessibility, so the semantics of elements must often be guessed. If the author followed the W3C Mobile Access Guidelines, many ambiguities would be resolved, and the

quality of conversion results would consequently improve. The Mobile Access Guidelines contain instructions to include alternative content and stress the importance of using the HTML elements only in their original semantic roles.

4.3. Media conversions

Media conversions and adaptation is required when a client (user agent) requests media content that is in a format that cannot be displayed by the client browser, or when the content cannot fit into the limits of the memory of the device. Other aspects include whether the display supports colours or not, what is the number of bits per pixel supported etc.

Images (WBMP, GIF, JPEG and PNG). The adaptation proxy handles the images of type WBMP, GIF, JPEG and PNG. The formats GIF, JPEG and PNG are read (encoded). GIF, JPEG and PNG images are converted to other format if required; the resulting format can be any of the following: JPEG, PNG or WBMP. The images can be scaled, and some image quality parameters can also be tuned during the adaptation in order to fit the image into the display of the requesting user agent.

JPEG2000. From the point of view of the media adaptation to mobile devices, the new JPEG2000 format [JPEG2000, JJ2000] provides many promising features. JPEG 2000 is ISO/ITU-T standard for still image coding, and it is based on the discrete wavelet transform (DWT), scalar quantization, context modelling, arithmetic coding, and post-compression rate allocation.

The JPEG2000 adaptation is not included into the current implementation of the adaptation proxy, but it is considered as a further research issue.

Vector graphics. Vector graphics should be very suitable for mobile use. For instance, the XML-based SVG (scalable vector graphics) specified by W3C is a promising format. Also, a mobile profile specification of SVG is under development [SVGmobile]. However, the current WAP devices do not yet support SVG images.

Audio and video. Audio and video formats provide several possibilities as well as challenges for media adaptation and conversions. The current implementation of the adaptation proxy does not handle the audio and video formats, but instead they are filtered out. However, the client browser (in addition to the used transfer path) constrains what media types can actually be displayed. The adaptation and conversion of audio and video media types is a further research issue.

4.4. Device adaptation

Device adaptation is based on the available information about the client device (browser). The HTTP header "User-agent" (if it exists) is used to give information about the client device and browser type. The "Accept" header gives information about the mime types that the browser should accept. These headers are used by the adaptation proxy to identify the client device (while the current devices do not yet send UAProf information within WSP headers "profile-diff" and "profile"). The proxy associates property parameters (such as maxDeckSize, imageCapable, allowColors, allowJPEG, screenSize) with the device. Note also that the other parameters used to configure the proxy (cf. chapter 5.6) are used in adaptation and affect the results.

Memory. Variations in device memory were taken into account. The default size of the WML deck was 1400 bytes. For the Nokia 3330 the size was increased to 2800 bytes, and for communicators larger deck sizes were also applied. In general, the larger deck size was helpful as more text fits the screen than on the other devices. Also, it was clearly useful to have fewer steps and larger pages on the Nokia 9210 communicator because browsing backwards was slow.

Images. Image conversion was adaptive (Figure 4). With smaller devices, the image appears as a link with the Alt-text of the image. If the user so chooses, he/she can choose to view the image on a separate card. The black and white WBMP format was the only format supported on most WAP phones. The Nokia 9210 also supports multi-colour JPEGs and the GIF format. For this device (see Figure 6), the images appeared within the page in original format (JPEG).

Figure 6. Image conversion can take into account the display properties of the device.

The Ericsson R320 and R380 models support GIF images in addition to WBMP. For these models, the following rule was used: the original GIF image will be returned if its size is less than 1400 bytes, otherwise the image is converted to WBMP format.

Also, constraints in the vertical and horizontal dimensions of the image were applied. For example, the maximum image size for communicator type phones was 192x144, and it was 96x96 for the others.

Text formatting. The proxy was set up to convert text formatting if the device supported them. The converted tags were i, em, strong, b, u, big, small and font size. Among the devices that were used in the field trial, text formatting was not implemented at all in the case of the Nokia 6210, 7110 and 3330 and the Motorola Timeport. The Nokia 9210 supported all formatting elements (Figure 7.)
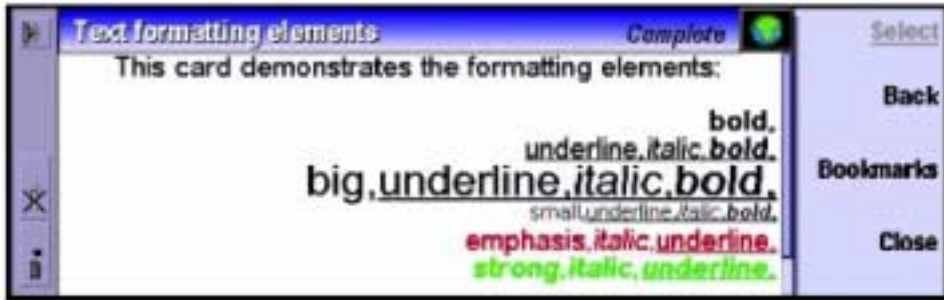
Figure 7. The Nokia 9210 utilises a plethora of methods for text emphasis (Nokia Mobile Phones 2001).

The conversion reproduced spaces and line breaks after conversion when necessary and removed extra line breaks. Without this, links and words may get connected when HTML tags are removed and especially when tables are deconstructed. Some WAP devices automatically insert line breaks after links.

Error messages. Instructive error messages were implemented. Each time an error took place, the proxy aimed to generate a WML deck, which informed the user and gave him/her instructions on how to overcome the error situation (see also chapter 12.1.2). The error deck consists of a short description about the error case followed by links for additional information, an error message and instructions. The error messages are categorised as follows:

- Errors generated by the Web server that includes the requested page (HTTP error codes)

- Malformed URL

- Connection to Web server cannot be established (commonly an error in entering the URL address)

- Error occurred during the conversion of the Web page.

- Content type (Proxy checks content type and returns an error message if the document is not of type HTML or WML)

- Empty content

- Requested image is too large or unsupported image type

4.5.   State management

The adaptation proxy also performs state management on behalf of the client. This is required because most mobile browsers are not capable of maintaining state information such as cookies. The state management with the adaptation proxy is based on cookies and user authentication. This enables the proxy to access many Web sites that require the user login.

4.6.   Profiling

The conversion and adaptation is governed by a set of "options". A subset of these options (parameters) is from the profiling information of requests, such as UAProf (cf. chapter 5.1) or the HTTP "user-agent" header. The options are internal to the proxy and the UAProf parameters must be mapped to these internal parameters. If UAProf is not available, the user-agent header of the request is examined. If it is not present or the specified user-agent type is unknown, a default set of options is applied. These defaults should produce a WML output that can be viewed with any WAP device.

The options are also used for setting general properties for the conversion, such as breakpoint priorities for various HTML elements.

The options are divided into four categories:

- System default options,
- User preferences,
- UAProf attributes, and
- Device class specific options.

Each of these categories of options produces options that are internal to the system, and belongs to a restricted total set of options that the system is able to handle.

Default options. The default options are stored in a default options file (in XML format):

```
<xmlconv-defaults>
  <feature name="AutomaticNextLinks" value="false"/>
  <feature name="CreateMediaDeck" value="true"/>
  <feature name="CreateIMG" value="true"/>
  <property name="NextLabel" type="string" value="\u2192"/>
  <property name="UpLabel" type="string" value="\u2191"/>
  ...
</xmlconv-defaults>
```

By modifying the default options file, the system functions can be tuned. The allowed option names correspond directly with the system inner option names, and any of these can be included in the defaults.

User preferences. In the same way as the default options, user specific options may also be included. The user preference file may have the same format as the default options file. This facility is not included in the current implementation. The selection of user files can be based on the user authentication information.

UAProf attributes. User Agent Profile information is related to the user agents via a user agent properties configuration file.

User Agent classes. User agents are grouped so that it is possible to set options that override the options of other categories. The user agent groups (classes) are stored into separate XML files. The classes are formed from the phones with similar properties (display size, WML version, deck size etc). A phone (user agent) belongs at most to one class. A class may include zero or more phones.

5. Evaluation set-up

5.1. Schedule

We evaluated mobile-transparent access both in the laboratory and in the field. The field trials took place from March to June 2000, and April to June 2001.

For most users, the trial took 6 to 10 weeks. Some users had the opportunity to use the trial services even longer, i.e. up to 16 weeks. The trial period gave the users the opportunity to use the services as part of their normal lives, whether it was work, studies, weekends, holidays or travel.

Laboratory tests with 4 to 5 users preceded both field trials. The purpose of the laboratory tests was to correct main usability problems before using the service in the field.

5.2. Data gathering

The data was gathered with several parallel methods: background forms, free-form feedback, qualitative thematic interviews, use log files and call logs.

Semi-structured thematic interviews. In the main, the users were interviewed three times: at the beginning of the trial, about three weeks from the start and at the end of the trial. The main themes of the interviews were as follows:

    1. Introduction – tasks, attitudes, instructions.

    2. Second round – difficulties, usability.

    3. Final interview – routines, user profiles, conclusions.

The interviews were conducted mainly at VTT in Tampere, at the home of the user or his/her place of work. Some users were interviewed outside their home, in coffee bars or parks. The interviews were recorded for further analysis. The interviews took from one to three hours.

Free-form feedback. Many users were active in giving feedback outside the interviews as well, especially if there was a technical problem or the service was down. Communication between the users and researchers was facilitated by the fact that the users had the phone readily available. Using SMS and e-mail in giving feedback was popular as well because communication was not bound with the schedules of the users and researchers. Some comments about services were also written on the Message Board.

5.3. Users

A total of 81 users took part in the field trials, i.e. 41 in 2000 and 40 in 2001. The users were divided into **Business users** (27 people) and **Private users** (54 people). They were aged between 14 and 79. The business users were from each of the participating companies in the WAP-UAPROF project.

In the 2001 field trial, the private users were further selected from five user groups, with the study of group communication in mind. In samples of five people, the groups were**: Birdwatchers**, **Choir members**, **Expecting mothers** and **Teens**. The rest of the users comprised ten **Individual users**.

The groups were chosen to represent different group communication needs. Mothers did not know each other beforehand, Teens were a group of friends, Choir members were used to organising events and Birdwatchers were assumed to have more informative needs, such as informing of bird sightings.

Figure 8. A wide variety of users took part in the trials.

Within these limits, the goal was to have users from many walks of life with a wide variety of demographic features and varied experience in using computers and different mobile devices (Figure 8). The users' social background was very heterogeneous, from students to managers, from housewives to farmers. The users' eagerness to use WAP in the trial varied also. This heterogeneity was a good initial state for the trial.

5.3.1. Private users

There were 54 users in the private user group, from which 27 were male and 27 female. The group varied very much in their experience with mobile devices and the Internet. Most users were at least somewhat experienced with mobile devices, PCs and the Internet.

Gender	n	%
Male	27	50 %
Female	27	50 %
All	54	100 %

Age				
Years	Male	Female	n	%
14–19	7	6	13	24 %
20–34	7	14	21	39 %
35–59	10	5	15	28 %
60–80	3	2	5	9 %
All	27	27	54	100 %

Mobile phone experience	n	%
Very versatile	6	11 %
Versatile	16	30 %
Somewhat versatile	16	30 %
Somewhat limited	8	15 %
Limited	3	5 %
Very limited	5	9 %
All	54	100 %

Computer experience	n	%
Very experienced	13	24 %
Experienced	22	41 %
Somewhat experienced	11	20 %
Somewhat inexperienced	3	6 %
Inexperienced	4	7 %
Very inexperienced	1	2 %
All	54	100 %

Internet and www experience	n	%
Very experienced	11	20 %
Experienced	21	39 %
Somewhat experienced	12	22 %
Somewhat inexperienced	5	9 %
Inexperienced	2	4 %
Very inexperienced	3	6 %
All	54	100 %

WWW use hours / week	n	%
Net open all day	4	8 %
> 20	1	2 %
10–20	3	5 %
7–10	7	13 %
4–7	9	17 %
1–4	18	34 %
0–1	7	13 %
Not at all	4	8 %
All	53	100 %

Pen-based palm device (2001 only)	n	%
Has not used:	27	90 %
Has used:	3	10 %
Very versatile	0	0 %
Versatile	0	0 %
Somewhat versatile	0	0 %
Somewhat limited	1	33 %
Limited	1	33 %
Very limited	1	33 %
All	30	100 %

Keyboard-based communicator (2001 only)	n	%
Has not used:	23	77 %
Has used:	7	23 %
Very versatile	0	0 %
Versatile	3	43 %
Somewhat versatile	1	14 %
Somewhat limited	1	14 %
Limited	2	29 %
Very limited	0	0 %
All	30	100 %

5.3.2. Business users

There were 27 business users in total, 12 male and 15 female. They were experienced with mobile phones, computers and the Internet. Those who had used palmtop computer or PDA devices were generally very experienced with these devices. Most business users were very experienced with mobile phones, PCs and the Internet.

Gender	n	%
Male	12	44 %
Female	15	56 %
All	27	100 %

Age Years	Male	Female	n	%
−25	3	2	5	19 %
26–30	2	9	11	41 %
31–40	5	4	9	33 %
41–60	2	0	2	7 %
All	12	15	27	100 %

Mobile phone experience	n	%
Very versatile	15	55 %
Versatile	10	37 %
Somewhat versatile	1	4 %
Somewhat limited	1	4 %
Limited	0	0 %
Very limited	0	0 %
All	27	100 %

Computer experience	n	%
Very experienced	23	85 %
Experienced	4	15 %
Somewhat experienced	0	0 %
Somewhat inexperienced	0	0 %
Inexperienced	0	0 %
Very inexperienced	0	0 %
All	27	100 %

Internet and www experience	n	%
Very experienced	19	70 %
Experienced	6	22 %
Somewhat experienced	2	8 %
Somewhat inexperienced	0	0 %
Inexperienced	0	0 %
Very inexperienced	0	0 %
All	27	100 %

WWW use hours / week	n	%
Net open all day	14	51 %
> 20	0	0 %
10–20	1	4 %
7–10	1	4 %
4–7	4	15 %
1–4	7	26 %
0–1	0	0 %
Not at all	0	0 %
All	27	100 %

Pen-based palm device (2001 only)	n	%
Has not used:	5	50 %
Has used:	5	50 %
Very versatile	2	40 %
Versatile	1	20 %
Somewhat versatile	0	0 %
Somewhat limited	0	0 %
Limited	0	0 %
Very limited	2	40 %
All	10	100 %

Keyboard –based communicator (2001 only)	n	%
Has not used:	3	30 %
Has used:	7	70 %
Very versatile	4	57 %
Versatile	2	29 %
Somewhat versatile	0	0 %
Somewhat limited	0	0 %
Limited	1	14 %
Very limited	0	0 %
All	10	100 %

5.4. Field trial services

The users had personalised front pages. From the front page, the user had access to both mobile-aware WAP services (Radiolinja WAP portal) and converted web services. The users could also write any web address and access it through conversion.
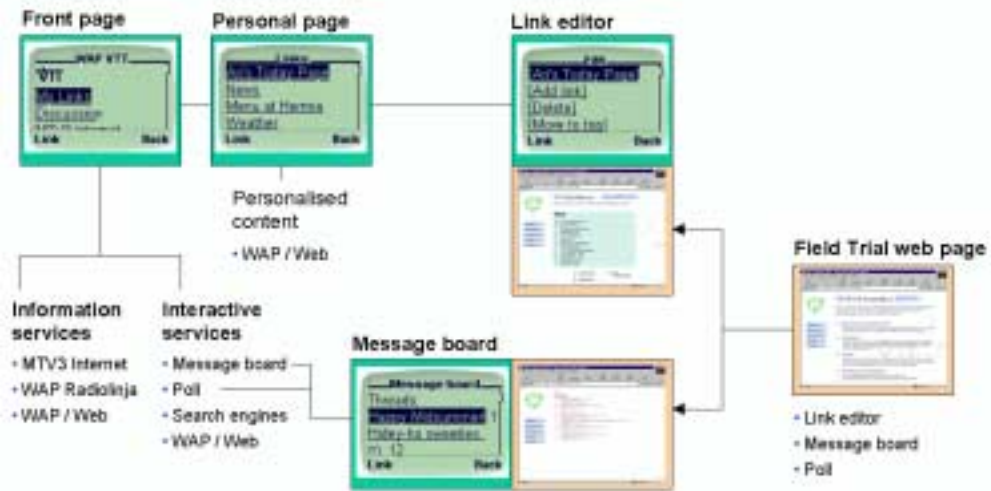
Figure 9. The set-up of field trial 2001 as seen by the user (screen views translated, original service in Finnish).

In the first field trial the front pages were tailor-made for each test user according to his/her interests. Users expressed their interests and recommended the links they wanted in their front page. The links were added to their page by the project researchers.

In the second trial, the first link on the front page led to the user's personalisable page (Figure 9). As an example, a few links were added for the users. The users could edit this page completely by adding and removing links or by adding notes. The users could edit the page either with WAP or with the web version of the link editor.

In addition to the personally selected web links, each user had access to the web portal of the MTV3 media company and the teletext services of two Finnish television companies (MTV3 and YLE). A light version of the MTV3 web portal was designed for the field trial to better support the WAP conversion. The main change was to provide a separate, simplified front page for mobile users and to pay more attention to the selection of link texts.

Additional common services in the 2001 trial were a web search engine (Google) and a WAP search engine (Evreka). Users were also free to try other available services, such as banking and e-mail, and were given help if needed.

The project proceeded by implementing and improving example services according to user feedback. The Link editor and Message Board were services that were constructed for this purpose. The conversion proxy was developed to include image conversion, text formatting, error messages and device adaptation. Also, the variety of public mobile services grew as the project progressed, for the benefit of the users (Table 1).

Table 1. During the project, the field of available services expanded.

2000	Personalised front page – mediated editing
	Web conversion, text only, manual device adaptation
	Radiolinja WAP portal (Walled garden)
2001	Personalised front page – online editing with Link Editor
	Web conversion, image conversion, device adaptation
	Message Board, Poll
	WAP portals (Open access)
	Search engines
	E-mail access when possible

Even though the users were happy with the tailor-made front page, some of them said that they would prefer to personalise their front page themselves by adding links and previewing them. The Link Editor tool was developed to fulfil this need. The Link Editor is described in Chapter 5.4.1. In the second field trial, each user had a fixed front page, common to all users, with access to a personal page with their own personalisable links.

During the first field trial, the participants mostly used information services, such as news and entertainment. The younger users in particular would have liked to use e-mail, chat sites, IRC channels or news groups. The convertible Message Board was developed to study self-generated content in WAP.

The structure of the project was mirrored in the interviews. One of the main factors of the interviews was "discussion with examples". The users tested example services and gave their opinions about them. In the process, users expressed ideas and made observations about other subjects that were related to their use. In a field trial, realistic use and true integration with the user's lifestyle is often difficult to achieve. The "discussion with examples" approach worked well even with users who did not use the service much, while at the same time it did not limit users who were more active.

5.4.1. Link editor

The Link Editor (Figure 10) developed for the project is a tool that is used in connection with the adaptation proxy for storing links to the Internet. It can be accessed from both Web and WAP browsers. In both environments the Link Editor can be used to view, edit, follow, add and remove links in the user's list of personal links. In web mode the user can also preview the conversion result provided by the conversion proxy. In addition to the personally selected web links, the users can write their own text notes and link them to their personal page.

Figure 10. The Link Editor in the web.

The Link Editor (Figure 10) developed for the project is a tool that is used in connection with the adaptation proxy for storing links to the Internet. It can be accessed from both Web and WAP browsers. In both environments the Link Editor can be used to view, edit, follow, add and remove links in the user's list of personal links. In web mode the user can also preview the conversion result provided by the conversion proxy. In addition to the personally selected web links, the users can write their own text notes and link them to their personal page.

Four different interfaces can be distinguished in the system: HTML and WML versions of both the Link Editor and the Link Viewer. However, from the implementation point of view, there is only one servlet written in Java. Four different user interfaces have been created by means of XSLT (eXtensible Stylesheet Language Transformations) style sheets. For each servlet request, the style sheet to be used is selected according to the client type. The translation from XML to HTML and WML is done on the server side, so that in principle almost any Web or WAP browser can be used as a client.

Technically, moving from editor mode to viewer mode is done by simply selecting another style sheet (moving from HTML mode to WML mode does not occur in practice during one session). In the HTML mode of the Link Editor, the user can preview HTML pages to see how well the conversion proxy manages to convert the page that has been selected.

For the user, the system produces the front page and the editor applications. The front page of each user was accessed with a unique URL, so that the users did not have to explicitly perform the log in themselves.

5.4.2. Message Board

In addition to the services that were described in earlier chapters, the **Message Board** (Figure 11) was developed by TeamWARE Interactive. It is a regular message board application for the web, which has been tailored to suit the conversion into WAP.

Figure 11. The Message Board in conjunction with the field trial web page.

Users could use the board with WAP or with the web. Any user could view messages that other users had sent. The messages were structured into threads, which in turn were part of a discussion group. The users could send new messages, thus starting a new thread, or reply to existing messages.

The Message Board service was set up for the four different user groups, namely Birdwatchers, Choir members, Teens and Expecting mothers. Each group was made up of five members. In addition to these four small groups, all 40 test users could access a common chat group called "Pulinapalju" ("Chatterbox"). There was a direct link to the Message Board login page from each user's front page.

5.5. Devices and subscriptions

In the first field trial, we used 3 different WAP devices: the Nokia 7110, the Ericsson R320 and the Siemens C35i. These were the only devices on the market at the time. Within one year, the number of WAP devices available had increased, which meant that the 2001 trial had 14 different WAP devices in use, as shown in Table 2. The browsers are described in detail in Appendix AI.

Ten device models were provided by the project: the Nokia 3330, 6210, 7110 and 9210 (prototype), the Ericsson R320s and R380s, the Siemens C35i and S35i, the Benefon Q and the Motorola Timeport 260. The devices that were used by the business users added to the variety: Nokia 6250, 9110, Siemens M45, Palm Vx.

Table 2. Devices and browsers used in the 2001 trial.

Device type	N	Model	Browser
WAP phone	2	Benefon Q	MS Mobile Explorer
	2	Ericsson 320	Ericsson
	1	Nokia 3330	Nokia
	1	Nokia 7110	Nokia
	16	Nokia 6210	Nokia
	1	Nokia 6250	Nokia
	2	Siemens C35i	Openwave
	2	Siemens S35i	Openwave
	1	Siemens M45	Openwave
GPRS phone	2	Motorola Timeport 260	Openwave
Smart phone	2	Ericsson R380s	Ericsson
Communicator	3	Nokia 9110	Nokia
	4	Nokia 9210	Nokia
Pen-based palm device	1	Palm Vx (+ Nokia 6250)	KBrowser WAPMan

The range of devices included different browser and device models, from regular WAP-enabled cell phones through smart phones to communicators (Figure 12). When extra devices became available, some users were given the opportunity to swap for another device, maybe one with a larger screen, or faster or a more stable browser. This way, a number of users were able to compare the services on different devices.

All users were provided with mobile subscriptions from Radiolinja to be used during the trial. There were loose limits for use, such as "Data services up to 10 hours per week". The use was not restricted technically and each user needed to monitor his/her own use, or check the accumulated bill with a current bill query

service. A number of business users opted to use their own subscriptions. The test trial restrictions did not apply to them. The purpose was to generate natural use while keeping bill-related worries to the minimum. Natural use also meant that the users could use the services in public and share them with friends and family.

Figure 12. The assortment of devices in the trials ranged from WAP phones through feature phones to communicators.

6. Activity of use

Information about actual use was gathered in both trials. Each time a user accessed a page through the proxy server (a HTTP GET or POST request), the request was registered into the log along with the date and time of the event. Within a page, requests for page elements were also registered. When an image was displayed to the user – i.e. the image was either displayed on the page or the user followed the image link – an extra request was logged.

In the 2000 trial, only the sum total and time of use was logged as opposed to individual users. Thus, the logged use also included an amount of test use made by project personnel. The requests for WAP pages were not logged because they were not converted.

In 2001, we were able to separate information regarding single users. Also, a WAP page could be logged if it was linked directly to the user's front page or personal page.

6.1.　Daily distribution of activity

In 2000, there were 30881 requests by all users (including members of the project group), while in 2001 the total requests generated by test users alone reached 43038. The difference can partly be explained by different schedule and phasing. The range of services available to the users in the trials may have had an effect as well. In addition, a few very active users gave the figures a boost in 2001. For example, the teens were the most active users of the service. They were also among the last users to complete the trial, which explains some of the high level of interest until the end of the trial in 2001.
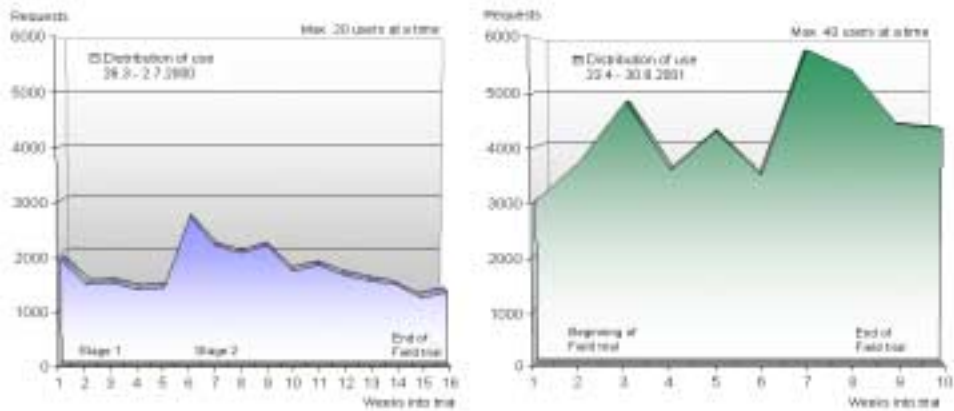
Figure 13. Weekly distribution of use in the 2000 and 2001 trials.

Figure 13 details the weekly distributions of both field trials. Please note that in the 2000 trial there was a maximum of 20 users at a time, while in 2001 the maximum was 40. Because of this, differences in the number of requests appear greater than they actually were. On the left, one can see how the amount of requests declines towards the end of the trial. Other points of observation are the beginning of stages one and two and the subsequent surge in use. On the right, in the 2001 trial, the interest for use remained at a high level until the end. One must note that the end and beginning of the trial and stages were not precise moments in time, but were carried out incrementally, with users starting and ending their trial on different weeks.

The daily use was mostly concentrated in the afternoon and evening (Figure 14). Late afternoon (4pm to 5pm) and late evening (9pm to 11pm) were popular times for use.
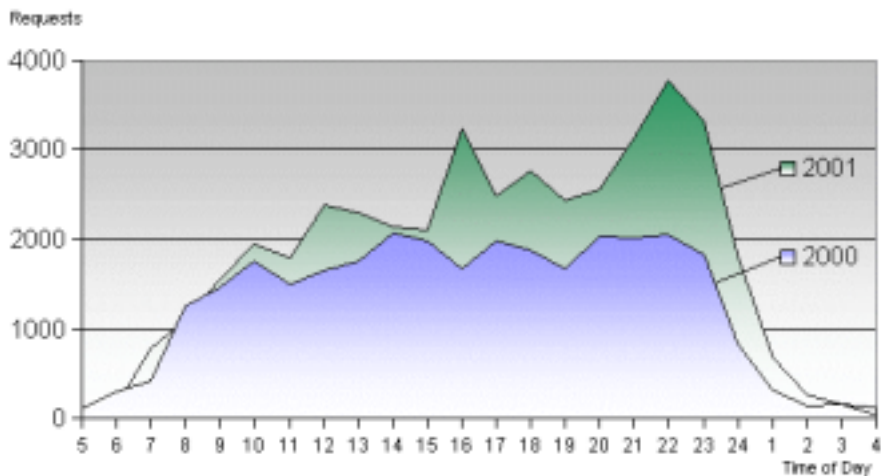
Figure 14. Distribution of use by time of day.

Users declared that they wanted to use the service when they had plenty of spare time. Short breaks during the day did not offer the best opportunity to get to know a new service. In this sense, the trial set-up may have skewed the use towards the evening. Had the users been more familiar with the service and had the service been more integrated with their daily routines, there may have been more daytime use. On the other hand, slow connections and/or service constituted a clear technical reason for not being able to use WAP unless there were several minutes to spare.

> Wap is more like an auxiliary device, something to use when you're on the road or too tired to move from the couch.

Second interview, 2001, female, 30

The evening use supports the observations made in the interviews that users used the services a lot when at home, for instance while watching TV. Users may feel that it is easier to visit the Internet with a mobile device than having to start their PC.

There was significantly less use in the morning and at night. However, there was some use around the clock. A few test users worked a night shift and used some of the time to read the news. Younger users were also active during the night.

6.2. Levels of activity among users

Based on the data gathered from the second trial, the users can be divided into groups according to their level of activity. The following statistics were produced by analysing the interviews and perceived activity level of each user (Figure 15). Users were then categorised as hyperactive, active, moderate or passive. Again, the limitation of such a grouping is that mainly conversion proxy use was logged. Use of mobile-aware services was only partly logged and avid users of mobile-aware e-mail services for example may be under-represented.
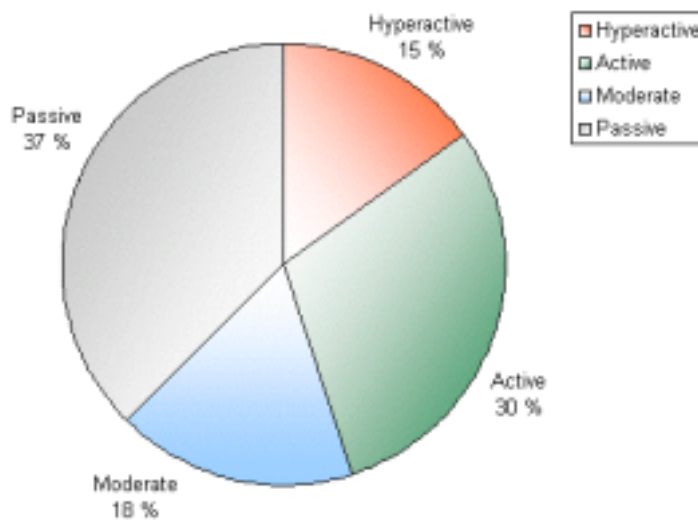
Figure 15. Users of 2001 trial according to activity level.

Hyperactive users. There were several users which can be considered "hyperactive" in their use. They used the services several times a day, and made on average 460 requests per week. Teens were the most hyperactive group.

Active users. As with hyperactive users, these were users that were genuinely interested in some of the services and checked at least one of them once a day or so. There were 141 requests per week on average by members of this category.

Moderate users. These were users who used the services on certain occasions during the week, and showed longer breaks in their use pattern. The average number of requests per week for this group was 78.

Passive users. Passive users in the main used the service only to pass the minimum requirements of the trial, i.e. to "have something to talk about" during the interviews. They often had little genuine interest in the services. Members of this group made 33 requests per week on average.

It must be noted that the above categories of activity describe *only* the frequency with which users used the services. A "Passive" user may use precisely the one service he/she requires and, as such, should not be considered any less of a user than a "hyperactive" one.

Figure 16 shows the **ten most active users** as well as the group they were a member of. The teens were clearly the most active, followed by a number of Individual users (users from outside the designated groups), Birdwatchers and Mothers.
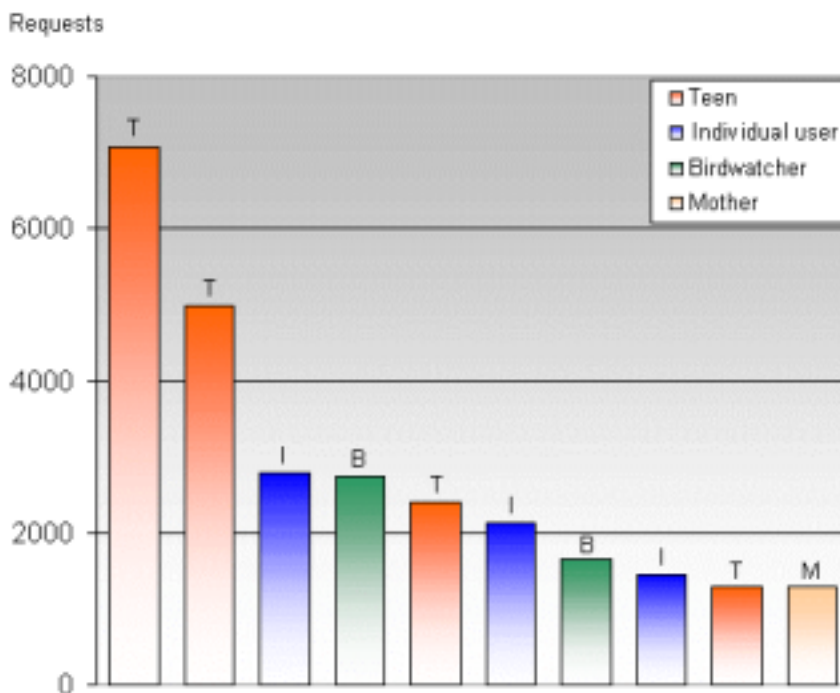
Figure 16. The ten most active users in 2001.

For the active teens, the Message Board was clearly the service that they used the most. Other services that were popular among the teens were MTV3 and the site for a Far Out–Reality TV show. MTV3 and the Message Board were the most used services in the case of the other active users as well. The exceptions to this were a birdwatcher and a mother with two small children. The services the mother used the most were the project Message Board and a public discussion group for mothers. The birdwatcher used e-mail and a strategy game the most. Each of the ten most active users had 2 to 5 services which they used regularly, with one or two favourite ones. They used all other services less frequently.

6.3.   Most requested pages

The most popular pages among all users are listed in Table 3, sorted by the number of requests. The list contains only the pages which have been logged by the conversion proxy. The requests for many of the WAP pages are not shown in the list, as we did not have the means to log them. A WAP page could be logged if it was linked directly to the user's front or personal page, such as WAP Evreka, which appears on the list.

The most viewed pages were MTV3 Internet and the Message Board's main page. The separate message board discussion groups figured high on the list, but have been omitted for clarity. A single active user could also cause specific services to figure highly on the list, as with NIC e-mail and a game called "Planetarion". The front pages of the most active users are also quite high on the list.

Table 3. Most requested pages in 2001.

Requests	Service
4669	MTV3 Main page http://scully.mtv3.fi/mfc/wapuaprofapu
2002	Message Board main page
774	Baby magazine discussion group http://www.vauva-lehti.fi/keskustelut/lue.asp
551	Newspaper (Helsingin Sanomat) http://www.helsinginsanomat.fi/teksti/juttu.asp

541	News (MTV3 Internet) http://www.mtv3.fi/wapuaprof/uutisapu.html
445	User's frontpage (Teen)
422	User's frontpage (Birdwatcher)
358	Image folder, MTV3 http://img.almamedia.fi/mtv3/
332	User's frontpage (Teen)
254	E-mail http://webmail.nic.fi/index.php3
253	User's frontpage (Private user)
219	User's frontpage (Birdwatcher)
210	YLE teletext page http://www.yle.fi/cgi-bin/tekstitv/ttv.cgi/10001/txt
206	TV program Far Out (MTV3 Internet) http://scully.mtv3.fi/msc/page_farouterik2
191	Game (Planetarion) http://www.planetarion.com/
189	User's frontpage (Teen)
180	Tabloid newspaper Iltalehti, PDA-version http://www.iltalehti.fi/light/
180	Search engine (Google) http://www.google.com/
170	TV-program page (MTV3 Internet) http://www.mtv3.fi/wapuaprof/ohjelmaapu.html
164	User's frontpage (Private user)
147	Wap search engine (Evreka) http://wap.evreka.fi/
136	User's frontpage (Mother)
130	User's frontpage (Private user)
130	User's frontpage (Birdwatcher)

130	User's frontpage (Business)
124	Weather service (Ilmatieteen laitos) http://www.fmi.fi/saa/
113	User's frontpage (Private user)
112	User's frontpage (Business)
110	User's frontpage (Teen)
110	Sports page (MTV3 Internet) http://www.mtv3.fi/wapuaprof/urheiluapu.html
103	User's frontpage (Teen)
103	MTV3 Teletext http://www.mtv3.fi/tekstikanava/100t.htm

As could be expected, most of the links on the list are ones that were on offer for each user on their front page. Adding a link to the front page, as opposed to the personal page, was a powerful way to get users to visit a service. MTV3 was among the first links on each user's page. When the newspaper Iltalehti was added to several user links, it too rose high on the list. This is an indication of how effective a "push" type of service could be under the right circumstances.

The list also shows how crossmedia use has started to infiltrate the services. There were three users who visited the site of MTV3's Far Out travel show several times to read the travel journals which the site includes. Earlier in the user logs, we already saw that the evening was a popular time to access the services anyway. Watching television is an activity which requires little attention, and as such can allow the use of mobile devices.

7. Usability of mobile-aware services

The observations reported here concern mobile-aware services (WAP). These refer to services that have been designed especially for mobile devices. Many of the observations that were made regarding the mobile-aware pages can however be applied to mobile-transparent (converted) services as well, and vice versa.

The mobile-aware services that users mostly used were WAP Radiolinja, bank services, e-mail and search services (such as maps and telephone numbers). Search engines for the web proved popular in the second trial.

The usability of mobile-aware services was found adequate at best among the users, the technical reliability not being as good. The various WAP devices used contributed to how the users perceived the usability of the services. Among the features that eased legibility or navigation were Navi™Roller-key (Nokia 7110), large screen (Nokia and Ericsson), colour display (Nokia 9210), scroll bar (Siemens), hyphenation (Ericsson), easy access from front page (Siemens) and high display resolution (Ericsson).

Features that hindered WAP use were for instance occasional browser hang-ups, slow response times when navigating and cumbersome text-input. These issues explicitly affected the users' motivation to use the services. The problems were alleviated somewhat within a year of the introduction of the first WAP devices, but the reliability could still be improved. The services themselves were found to be more usable than converted web:

> I've used Radiolinja WAP portal the most, because you
> know that the information you're looking for is there
> (e.g. weather). On other pages [..] you surf for ages
> and don't get what you want.

E-mail 25.4.2000, male, 26

The main usability problems with WAP applications include support for navigation, scrolling the text and using input fields. These problems are discussed in more detail below.

7.1. Navigation

Getting lost. On the small screen, the structure of the service is often difficult to perceive. It is easy to get lost within the service. Users commented that they experienced problems both in finding the information that interested them and in getting lost in the information itself. Information about a user's own location in the WAP-space is as important as knowing the location of certain information. Users described the following problems in navigation:

1) How can I find the information that interests me in the WAP?
2) Where am I now?
3) How can I find the information that I am looking for from this service?
4) How much information is left? Cf. WWW-browsers scroll bar.

The fear of getting lost affected the users' navigation through the pages. Users were shy to venture away from their starting point, and rarely visited additional links on the pages. Also, when a user entered a page that seemed too long or complicated to use, he or she often returned back to the front page.

> You have to know what you are looking for and also how you've got where you are, to know how to get back. In the net you can make sudden moves, but in wap you have to surf backward and forward.

> **Second interview, 2001, female, 30**

Endless scrolling is one of the disadvantages of a small screen. Browsing a service can imply lots of scrolling for the user. Unfortunately, scrolling is not the same as quickly glancing through items, as with a newspaper. That is why the order in which the information appears on the screen is important, meaning that the most likely choices should be presented first.

> There's quite a bit of click-click-click.

> **Second interview, 2000, female, 29**

Even when the user knows that the item he/she is looking for is at the bottom of the page, he or she can still easily give up scrolling. Even on shorter pages, the users are unlikely to peek at the links which may lie under the first screenful.

Scrolling was a bigger problem with converted services, because of the large amount of data per page.

Back navigation should be possible from each page but not all browsers automatically have a "Back" button. The Nokia browser is one example of such a case. Not being able to go back from a service is very frustrating. There are services which do not have the <prev> element on their front page. This element provides the back-browsing option in browsers that do not automatically have it. Users will start to avoid a page that does not provide the possibility of going back.

Navigation history. Users expressed the wish that the browser be able to remember the links they have visited previously. This would help users find information by showing which links/pages have already been visited. The browser should also remember that point on the previous page from which the user entered. Navigation back to the previous page should lead to the entry point and not to the beginning of the page.

```
When you return to the previous page, the browser
should return to the exact spot where I left off, and
not jump to the beginning of the page. Like when I'm
reading the news, it's real s*itty to be reading the
last news item, then press back and find myself at the
top of the news list : It would be so much easier if
the browser returned to the news item link, where I
chose the item.
```

E-mail 24.3.2000, male, 19

7.2. Content and presentation

Content-wise, there was a feeling of not knowing where one could find interesting services. The mobile net felt impersonal and faceless. This situation improved a little with the advent of search engines that could search through both web and WAP sites. The personal nature of the content could still be improved.

In 2000, the variety of WAP services was limited by the "Walled Garden" approach. This approach means that the operator restricts the access to the WAP pages of other service providers. Users did not favour such an approach and fortunately many portals have abandoned it. In 2001, the availability of services outside portals and the introduction of brand new WAP services raised the amount of WAP services that users could browse.

Refined site hierarchy. The users proved wary of navigating far from their starting point, yet many sites use a simple tree hierarchy as their site structure. The user may need to browse through from the top concept (News) to the actual news item through submenus. When designing a site, it is recommended to think further than in terms of a simple tree structure. For instance, the user should be able to access the latest news items without going through News -> News provider -> Local -> Today - > News item. The last item in the hierarchy is often the one the user is looking for, and there should be a way to make it directly accessible.

Layout consistency within the service was another feature that users expressed a desire for. The layout should be the same on each page so that users can easily understand the structure of the page.

Consistent layout can also be a problem when, on a monochrome display, there are few visual cues to choose from. Both navigation and services will benefit from colour displays and simple graphic items, which can be used to separate one service from another.

Text formatting, such as **bold**, underline and *italic*, was believed to help in visualising the structure of a page more rapidly.

Informative naming of links and headings is important. Service designers should be aware that the user can access the service from pages outside the service. Thus links with names such as "Front page", "Home" or "Start-up page" do not give much navigation support to the user.

7.3.   Input

Unless one is used to it, **text input** with a numeric keypad can be quite slow and cumbersome. The usability design guidelines of the device and browser manufacturers advise to avoid input fields when possible, and for example to use selection lists instead. Problems were observed especially in banking and search services. It was found especially frustrating not to know whether the service accepted capital letters or not. The services differed in this respect. Too often there was also inadequate feedback when the search failed.

Additional observations concerning text input were made on the Message Board and are reported in Chapter 13.1.1.

Selection fields are not without their share of problems. Users fail to realise that there are options to choose from. For instance, with the Nokia 9210, a selection field looks like a regular text field with text in it. There is no indication on the screen that more options are available if the user presses Enter (Figure 17). Part of the problem can be remedied by adding an "empty" first option, which gives the user a cue as to what to do, e.g. "Choose option". Unfortunately, browsers interpret this cue as an option and also present it as such.
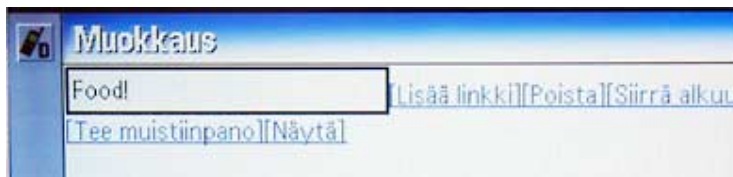
Figure 17. Selection fields do not always indicate clearly that there are options to choose from.

8. Mobile-transparent information services

Mobile-transparent information services were available in both trials. Mobile-transparent services were provided via the conversion proxy which converts and adapts web services for different WAP devices. From his or her personalised front page, the user had access to four kinds of converted services:

1. A selection of the web services of MTV3 (Figure 18) via the WAP proxy server: news, hobby groups, web pages of popular soap operas etc.

2. Teletext services via the proxy server. Teletext services were familiar to most of our test users. In the WAP front page, we included links to the web versions of the teletext services of two Finnish TV companies.

3. Personal web links via the proxy server. These links were available from the user's web page.

4. The last option on the user's page was to input the URL of any other web page to access the page through the WAP proxy server.

8.1. Usability

The usability problems experienced with the converted content were very similar to those experienced with mobile-aware WAP services. The users often felt lost if they proceeded too far from the top of the page or from their index page. If the original web page was familiar to the user, it was much easier to navigate within the converted site. The users would have needed more navigation aids to ease browsing and facilitate movement within the site in larger increments.

> It seems real important to know the site. If the site is familiar, it's easier to navigate.

Final interview, 2000, male, 37

8.1.1. Tailored example service

A selection of the web services of the MTV3 TV company was redesigned for the field trial, taking the W3C Mobile Access Guidelines [W3C99b] into account. The content that was accessible via the WAP proxy server included news, discussion clubs, hobby groups, web pages of popular soap operas etc. The main change was to provide a separate, simplified front page for the mobile users. Most sub-pages did not require any modification for mobile use.

Figure 18. A light version of a complex front page will ease navigation to convertable subpages.

Taking user feedback into account at the beginning paid off during the trial. The converted service received positive feedback and proved popular among the users. With pages that were properly optimised, such as the news section, the users did not notice that the pages were not designed especially for mobile devices. Many users deemed the subdirectory division and article length suitable to them. For some, the service was even easier to use than the web version:

> What I found a bit surprising was that I looked at MTV3 on the web and I think this [WAP] version is a hundred times better. Perhaps keeping it simple is the key.
>
> **Final interview, 2000, male, 37**

Optimising a service according to guidelines appears to result in a convertible site, but users also need to have their say in how the content hierarchy is structured. For instance, log information of the most popular pages on the site can be used to provide mobile users with easier access to them.

8.1.2. Converting the web

Free access to the Internet was considered a great possibility for mobile users, especially at a time when media coverage talked a lot about how limited the WAP content was. Users understood quite well that all web pages could not be converted, but were still frustrated when they could not access a particular page.

There were three main pitfalls that hindered the users' experience. These consisted partly in text input, the difficulties in conversion, and in the nature of the pages that the users attempted to convert.

The pages that were difficult to convert and navigate were complex front pages, login pages and schedules. Easier to convert were single subpages and frames, light version of services and simple information pages, such as sites for small communities.

The unpredictability of conversion errors. It is difficult to predict which kind of page will convert and which will not. The users understood that all of the WWW could not be converted. The unpredictability, however, was less easily understood than the non-convertibility. Writing a web address was often done for testing ("Let's see if this will work"), rather than using ("I'll just check out this page.").

> If you make that kind of effort, you should get the service.
>
> **Third interview, male, 37**

The early WAP devices also suffered from error messages that did not differentiate between connection errors, link errors, oversized pages etc. All were described in one or two simple messages such as "Page cannot be loaded" or something similar. Users did not know whether the service was unavailable

permanently or temporarily. The user is not likely to return to a page once he/she has been shut out on a previous occasion.

Later in the project, the unpredictability was countered with the Link Editor, with which the users could preview how the page would look on their phone. More descriptive error messages were also implemented. The users then received a message in plain language stating the reason for the error and instructions on how to proceed (Figure 19).

Figure 19. Users need a plain-language error message which differentiates between different causes of errors. An instruction on how to proceed is recommended. The original message from the proxy server is included as well.

Logging in. Users sometimes tried to access "book or record of the month" clubs. They were also interested in browsing catalogues, such as book and record stores, net auctions and net magazines. Many of these sites required logging in, which proved somewhat problematic. The login was, for instance, implemented in JavaScript, which the proxy does not convert. In some services, the web version requires a login, but the lighter, mobile version does not.

Logging in through simple, form-based, logins was improved during the trial.

8.1.3. Navigation in converted web content

There are a number of issues that come up when regular web content is converted to a small screen. Many of these problems come from the fact that the content has to be fitted onto a small screen, which leads to a lot of scrolling without proper knowledge of the rest of the information on the page. Some of

this can be addressed with changes in the conversion, but more could also be done with minor changes to the design of the site.

Navigation through front page. Most users write in addresses of the front page of the web service. They do not remember or do not know the addresses of subpages or single frames. Front pages are often made to look graphically appealing and to offer the appearance of a large content, which also tends to make them complex to convert and navigate.

Users were instructed on how to direct their links to subpages. This, however, appears to be a feature for advanced users. Finding out the URL alone takes a lot of effort. In this case also, the ability to preview the page is one answer. Another option is for the content provider to provide a light version of the front page.

Reoccurring links. An issue that was linked to scrolling was the structure of web pages. If a recurrent page element is on the top or left side of the page, i.e. a menu or a link list, it is repeated each time at the top of the converted page. The user needs to scroll through the menu on every page, as illustrated in Figure 20.

Figure 20. The web menu on the left is shown first on the mobile screen. If the menu re-occurs on the following page, the user will think he did not leave the previous page at all.

E-mail 23.3.2000, male, 19

Scrolling was a bigger obstacle with converted web pages than with mobile-aware services (Figure 21). Some users wished for a clear indication of where the page would end, such as a scroll bar or even a symbol at the end of the page.

Figure 21. A rather straightforward web page will squeeze into a long and narrow strip when viewed on a small screen. Moreover, the strips need to be cut into slices small enough to fit into the device memory.

When there were enough line breaks to make it appear that the screen was empty, the user would stop scrolling. The conversion proxy limited line breaks to a maximum of two in a row. This helped alleviating some of the problems related to scrolling.

Often, the negative feedback about scrolling concerned pages which the user felt were uninteresting. If the content was interesting the users were ready to scroll and read rather long texts. This was found to be the case by Ramsay et al. as well. [RAM00]

Understanding links and terms. Informative naming of page titles, links, terms, frames all the way down to file names is important in designing convertible pages. In particular, the naming of frames needs to be carefully thought out. Figure 22 shows how a frame structure can turn into a frame menu, which can be difficult to decipher.

Frames were elements that could lead the user to a complete stop when trying to navigate further within a site. The file names often give little information on where the actual content is located. Previously, the proxy used the file names as links to different frames that constitute one page on the web. Once the actual titles of the frames were implemented to these links, they gave a more accurate idea of their contents.

```
Frames and other elements of the page structure that
are shown to the user but that are invisible on the
PC,  are  confusing.  It  makes  the  service  look
unfamiliar unless you know it completely. For many
people this endless rolling around on different pages
can  be  frustrating.  Unless  you  bookmark  the  page
(which I've only tested) it's difficult to find your
way through nonsensical tag texts.
```

E-mail 25.4.2000, male, 26

Frames, however, do not have to be avoided. A direct link to a frame, such as the menu of a site, is a better solution than a link to a page with layout tables. Linking to content elements instead of the complete page becomes easier. One could also experiment with a solution that conjuncts frames into one page for devices with larger screens and memory.

The problem with naming occurred in images as well, although not as severely as with frames. Images that are not converted appear as the alt-text of the image. Also, the image can be seen as a link to the image, as can names after the alt-text. Proper use of the alt-attribute is essential, and in graphic menu buttons it is crucial for navigation.
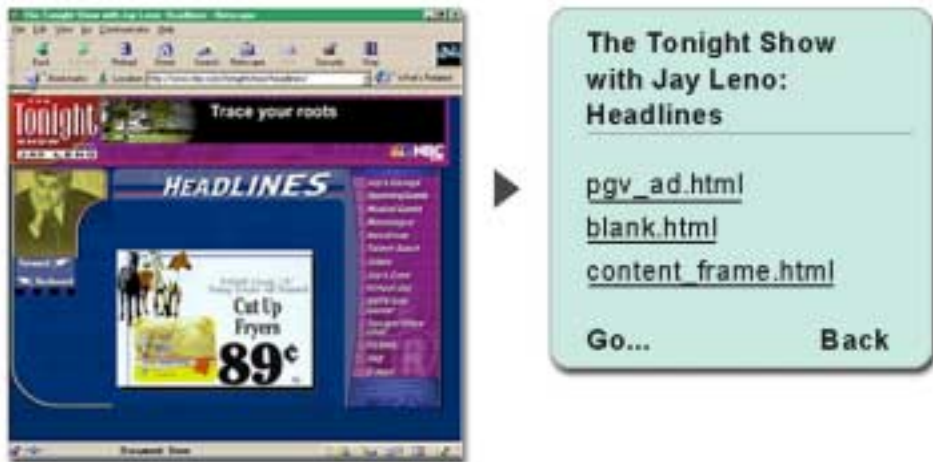
Figure 22. Names of frame files can help navigation if they are informative enough. Having the proxy use the title of the frame as link is preferable.

Automatic selection of content. Some users wanted the system to know how to strip away content that was not usable or relevant. They felt the information content should also be adapted to the mobile device.

> That's one big challenge for a wap parser. One solution would be to mark wap-only segments of the page and to leave headers plus other "invisible/non-functioning" parts out. For instance, <|- WAP> Updated information <-wap-|>

E-mail 25.4.2000, male, 26

Once XML-based web gains more ground, the above scenario will be easier to accomplish. Relevancy of information, however, is often a decision that only the user can make. In the field trial, users were quite happy to read long articles, up to a complete guide on mushrooms in the case of one user, as long as they found the content interesting. Also, simply cutting away non-convertible information can lead the user to believe the content provider has left some crucial information out. One solution would be to provide a compact or quickly browsable version of the content, but leave the option for the rest of the content as well.

8.1.4. Device adaptation

In current mobile services, a single version only is made for all devices. Devices which could benefit from having a larger screen and better resolution are actually the ones where the services look the least attractive. In particular, black and white WBMP-images end up looking small and puny on a high-resolution colour screen. Screen space and memory are not taken advantage of either. Device adaptation was implemented incrementally during the project. This meant that different versions of the converted pages were available on different devices.

The main challenge in the device adaptation is the large variety of devices. Screen sizes vary from 2 to 3 lines of text to ¼ VGA in communicators. On-screen navigation may be supported by a pointing device or merely a simple up/down key. Keyboards include full QWERTY keyboard, on-screen keyboard and phone keypad. The keyboard may include WAP specific keys like Back, Forward and Options, but the designer cannot rely merely on these because they do not exist on all phones. Even in WAP phones, the philosophy behind the browser user interface is different. Openwave browsers are designed for phone-like usage, utilising the phone keypad a lot. Nokia and Ericsson browsers are designed more specifically for web-like usage, utilising links and soft keys on the screen. The capacity of devices varies, allowing 500 to 4000 bytes for a single page. Support for different user interface elements also varies a lot.

Our conversion proxy server adapted the presentation of the services in terms of, for example, text effects, amount of data the device could receive at a time, screen size, image support and initial focus on the page.

The following comments have been put together using observation and user comments. They indicate what could be done to improve the conversion and how device features could be better utilized.

Memory. Fitting the pages to device memory was accomplished by cutting the page into separate decks, which can be fetched one by one from the proxy. The cards were separated by three dots "...". The word "More" was used earlier, but users preferred a symbol.

Users were generally in favour of longer pages, without as many cuts into separate cards. Especially with devices that have larger screens and slower browser, such as the Nokia 9210, it is easier to read and navigate long pages. On the other hand, with a quick browser and a small screen, cutting pages can be an asset that minimises scrolling and may ease back-navigation.

Images. Images were converted for different devices as was described in Chapter 5.3. A discreet approach was taken in order to avoid image clutter. Users widely agreed that so far, the strength of WAP as compared to web in mobile devices was clarity and speed. They did not want to sacrifice any of the speed in favour of images.

On smaller devices, the discreet approach included a link to the image, rather than images appearing without the user choosing to see them. Users agreed that the link approach was wise. However, sometimes the link went unnoticed and many users did not realise that there were images at all. With the Nokia 9210, the images were converted automatically within the page. The users did not object to this, especially because the images were rather small. With the Nokia 9210, users would have liked larger images, or the option to zoom to a larger image.

Although images were not considered very necessary, users quickly got fond of them, especially if they had a colour display:

> Pictures and the colour display were really positive improvements, they ended up meaning a lot more for the user experience than I had expected, even surprisingly so.

> **Field trial journal 2001,** female, **23**

With colour displays, users thought the images could be larger. One possibility would be to provide an option which allows the user to enlarge an image.

The quality of WBMP-images was considered adequate at best, but very poor in many cases. The only device to support colour images in the trial was the Nokia 9210 (Figure 23).
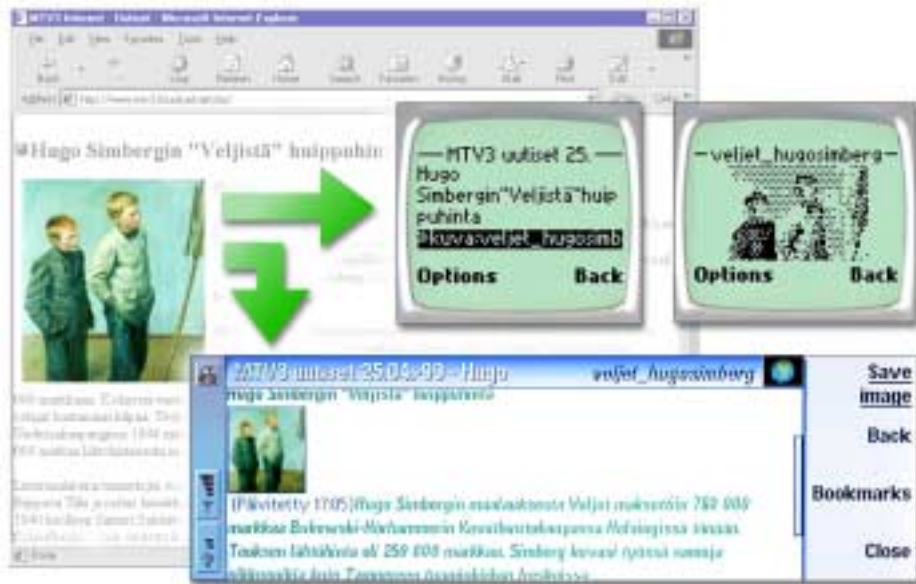
Figure 23. Image conversion of a news item for a regular WAP phone and a PDA with a colour display.

Text formatting. Text formatting was implemented during the trial. The proxy converts regular formatting, such as **bold** and *italics,* into text with strong or emphasis. The device browser decides what form the visual look will take.

Using text formatting is beneficial in all models that support it, as it gives the text structure and can even be crucial on some pages.

If the device does not support text formatting, other equivalents can be considered. For instance in Figure 24 the timetables are very difficult to read without the formatting. Emphasis could be added to these devices with *asterisks* or _underscores_ .
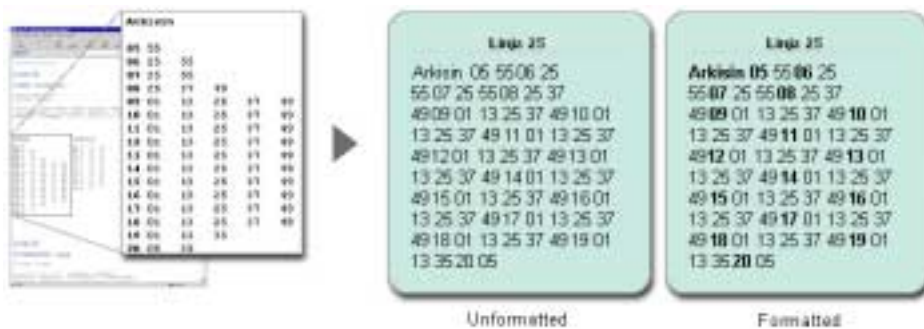
Figure 24. Text formatting can be quite crucial with some services. In this converted view of bus schedules, each beginning hour is in bold letters.

Links. The phones use different ways of indicating links, such as underlining, [Brackets] and <greater/less than signs> . This makes it difficult for the site designer to use these visuals for separating commands from regular links. If one uses brackets, some models will add their own brackets as well, which will lead to links with [[double brackets]]. This looks unattractive and wastes valuable screen space as well. There is room for device adaptation in how links for commands are visualised.

In Nokia phones (excluding the 9210), links and images reserve separate lines even if line breaks are not used. This solution makes it difficult to design a service which would look balanced in all phone models. If, for example, the link is in the middle of a stretch of text or several links are adjacent, the separating space can take away additional room from smaller screens. On the other hand, if service designers fail to add line breaks or spaces, links can appear as one big link.

Tables. Converting tables correctly was a challenge. In most instances, the table needed to be deconstructed rather than recreated for the small screen. In general, users considered tables with links to cell content as inconvenient. Also, the browsers had different ways of presenting tables (Figure 25). Users preferred the borderless view.

Figure 25. Different ways of visualising tables: the Nokia 9210 and Ericsson R380. The original table does not have visible table borders, but the Nokia 9210 uses them. The Ericsson R380 opts to drop the borders off in every table.

More complex algorithms need to be developed for tables, but as default action, deconstruction seems to be the way to go. The support for tables is not an indication that tables should necessarily be used, but instead larger screen size is. Some rules of thumb can be suggested on how to manage tables for different devices:

1) Device with a large screen with support for tables

Rather complex tables could be converted as they are on the original page. The issue with these devices is device memory. The cell contents can be shown as a small sample with a link to the whole cell content. If only small samples of text can be displayed within cells, then deconstructing the whole table into links or plain text should be considered. If the device can display a lot of the table content as it is, without resorting to cell samples, then recreating the table can be considered.

2) Device with a small screen with support for tables

At the least, simple, two celled layout tables (i.e. menu cell / content cell) could be presented as links to the cells. This appears to minimise scrolling, because the reoccurring menu links can be passed more easily. Complex tables should be deconstructed into plain text.

If the device supports text formatting, one could develop visual cues for expressing the structure of the table even though it is no longer in place. For instance, if there is only a small amount of text per cell, the first cell of a row could be in bold letters. Timetables are a good example of this kind of table conversion.

3) Device with a small screen, no support for tables

This device requires a process similar to that in item **2)** above as far as converting tables is concerned. In this instance however, the case is more straightforward since tables cannot be used.

In all these instances the difficulty lies in determining what constitutes a "complex" table, what is a "simple layout table", and how much cell content warrants displaying a sample of the content or systematically displaying the complete content.

8.2.   Usefulness

The users were quite enthusiastic about their personal links. Personal content could include home pages of family members, web pages of a local sports club, web pages of the user's own university and similar personal data.

Users were also prone to try out front pages and schedules for trains and buses, which unfortunately were difficult to convert. This reduced the usefulness of the service somewhat. On the other hand, simple personal pages were often a delight for users who considered the current WAP services somewhat sterile and impersonal. The wider content gave users the opportunity to select more personal information.

Despite being available from all kinds of media, the news was nonetheless a popular content. Although a number of users were mainly interested in e-mail and searching for information, news items were still the favourite content for most of the users.

Figure 26. Whether at home or on the move, teletext content suited mobile access well for its compact nature, prompt updates and convertibility.

Teletext services were an example of services which converted well and were found useful. Both major Finnish teletext services, MTV3 Tekstikanava and YLE Teksti-TV, were available through the web and consequently, in out service also. Users were familiar with the teletext services, which are quite similar both on the web and on TV.

Due to its compact nature and familiar method of navigation, the teletext content worked very well on WAP (Figure 26). However, users clearly preferred a teletext service which had the operations menu (e.g. "Next page/ previous page") at the end of the page rather than at the top. Also, several ads could hinder the user experience.

Teletext services, especially YLE Teksti-TV, were also popular because users knew that the service offered the most recent information. Updated information

was found especially useful when there was an on-going strike, sudden accident, or a special occasion which were unfolding:

> 29.3. I was keen to find out this morning whether the
> bus strike would start. The latest information came at
> once from wap. I could check the situation as I was
> putting my clothes on. I was in a hurry as usual. I
> took the phone to school with me to be able to follow
> the negotiations (the damn strike did continue).

E-mail 2.4.2000, female, 35

> During the transport union strike I followed the
> situation quite closely with the service. The hockey
> league might have been another thing to follow, if my
> favourite team hadn't been eliminated from the semi-
> finals....

E-mail 19.4.2000, male, 37

In some cases, the user's TV did not have teletext reception, in which case the user could still access it with the phone while watching TV. This is an interesting observation, since mobile devices are often considered to be useful only when other media sources, such as TV and PC are not present.

Mobility – or at least portability - can be a major advantage even if the user is at home and/or has easy access to a PC. McClard and Somers [MCC00] studied web-tablet integration into home use. Three of the defining characteristics of the web tablet were *location*, *position* and *integration into other activities*.

- *Location* within the home can be anywhere, as opposed to a static PC. In the study, the families involved used the tablet in every room in the house, including the bathroom. The tablet was most used in the living room and bedroom.

- *Freedom of position* is one of the advantages of a portable or mobile device. The device need not be used at a desk, but can be used on a couch, easy chair or in bed in relaxed and comfortable positions.(Figure 27).

- Portability allows for *integration into other activities* more so than with a static device. The web-tablet was used in parallel with "watching TV, doing chores, socialising, eating, using the main PC, and talking on the phone".

Figure 27. Mobility at home: freedom of position.

These observations coincide with our trial results as well. Much of the trial use took place in the evening, which places usage in the users' homes rather than in mobile situations.

In conclusion, one can say that information services on the web offer content, which the users would like to access. Users can access both the personal sites and news sources they are accustomed to. Users widely agreed that conversion of web content for mobile use is something that should be developed further. The information that can be accessed through the Internet can make mobile services both more familiar and more personal.

9. Interactive Services

This chapter regarding interactive services covers both mobile-aware and mobile-transparent interactive services. There were several interactive services available to the users. The services that are examined here are the Message Board, e-mail and search engines. These three services are similar in their need of user input and also because the user experience is similar to that of a converted service. Users have the source of the information, be it e-mail, search engines or message board, and can access it either through conversion or through a mobile-aware interface.

Observations of the Message Board, its usability and usefulness were analysed in detail. This provided a good example of the potential and pitfalls of a mobile Internet communication service. We have also provided an analysis of the communication needs of five different groups and the manner in which these needs could be met with a Message Board service.

The search engines are considered more from a point of view of usefulness and integration to the users' information needs. Mobile E-mail is also discussed.

9.1. Message Board

9.1.1. Usability

The Message Board service is an example of a mobile-transparent interactive service. It was available on the web and converted for mobile use. All users could use the Message Board to read and send messages, although with great difficulties in some cases. Users also commented about the service a lot and suggested improvements. The main comments entailed problems in sending long messages, reducing the number of steps needed to read messages, emphasising new messages and clarifying service hierarchy.

Logging in is a big hurdle in mobile devices. Remembering passwords is always difficult but particularly with mobile devices, entering text is an extra effort. In the trial, there was a separate login to the board.

The users' usernames were formed by their initials and their passwords as two random letters plus their year of birth in double digits. Even this was considered difficult. For instance, the users needed to switch from character mode to number mode, which caused some nuisance. In real-life services explicit login by the user should be avoided.

If the user misspelled his/her password or username, the resulting error message did not clearly state that the user should check the spelling.

```
Sorry to bother you right at the start but when
I write my name and password to the message
board I get "No server access". What am I doing
wrong?
```

Text message, 2001, male, 18

The devices often assume that the text the user is writing is an upper-case letter, which makes writing passwords error-prone. In this case, passwords should be case insensitive. Hiding the password (****) can be a hindrance as well, although necessary.

When a user logged out, he/she was forwarded to the login page. This was confusing to some users. On log out, there should be a message confirming that the user has logged out as well as where he/she has logged out from.

Emphasis on new messages. The most common remark about the structure was that new messages needed to be accessed more easily. The number of steps required to get to them needs to be reduced. New messages need to be more prominent in the service (Figure 28). Users had trouble noticing new messages if they were replying to an existing thread.

Generally, the mobile service should be designed in such a way that the most frequently used options are the first ones on the page. Ideally, the latest new message should be the first item in the service. If there is only one message in a thread, there should be no thread page between the title and the message. The user should be taken straight to the message.
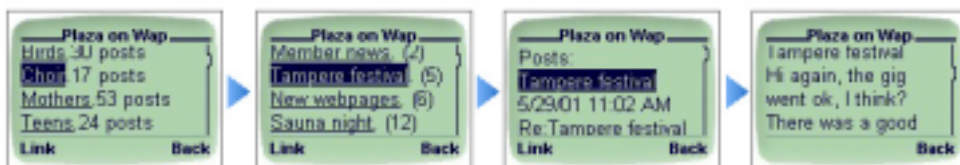
Figure 28. Reading one new message required too many steps.

The service could also be very much improved by including a "New messages" section. This would allow the users to see at a glance how many new messages there are, and to access them without going through the group-thread-message hierarchy. Users could access the threads through the messages, but not vice versa.

> If I take a message like "Sävel" or something, then first I get the messages and when I select the message – for instance there was four messages in the choir pages when I first went there – I pressed one link of the four to get the message. Then it says "Read message", "Next message", "Previous message"! Why couldn't it just go straight to it, you can get back from the message if it wasn't the one you wanted. There are just way too many steps! It would be nice if you could cut them somehow.
>
> For instance, it's understandable that if I go to the Choir pages it shows me the titles of the messages, but when I select a title, it won't go there...it just shows "Read message". That's the step that frustrates me. It's like, "What? Again? Why aren't you showing it to me already!?"
>
> **Second interview, 2001, female, 32**

With the new messages section, the current structure of the service would be preserved as a kind of archive. There were some differences in how users wanted to explore the hierarchy. Adult users wanted to delete older messages "out of the way", while teens felt it was important that the thread history should be left as it was.

The users had a lot of problems with navigation. It was difficult for them to discern where they were in the hierarchy. Regardless of location, titles appeared

as links and message threads looked like messages. Sometimes this resulted in messages being sent to the wrong level in the hierarchy. Sometimes a message was written by accident in the field of the title. Some users said that this was a clever idea to accelerate the reading since the reader then did not have to open the actual message. The hierarchy needs to be more clear-cut.

Alarms. Users wanted to be alerted when they received a new message. All members of the birdwatcher group had used pagers and were familiar with alerts. They wished that the message board could send an alarm tone like beepers do when a new message has been received. The sender should have the option to choose whether the message will set off an alarm or not (like low and high priorities in the case of e-mails). Also, the receiver should be able to personalise the alert level (ringing tone, vibration, symbol, colours).

Entering text was difficult. In some devices, the input fields on the screen were too short. The user had to complete the input while only seeing the last few characters of the message they were writing. It seems that active user input has not been adequately considered when designing WAP browsers. For instance, Palm's WAPMan only shows a small text field. Once the field is full of text, the user has to write the rest of the message without seeing what he/she has written. The Nokia 9210 also suffered from a small text field. Users commented that predictive text input would be very helpful when writing text in any input field.

> Then there's the thing that I kinda like writing to these [discussion groups] and all. And I like reading with that thing, but it's just soo difficult to write. I'd rather have a keyboard and write – trrrrt! – the reply, like dozens of messages, for sure. But I'm not gonna write one at a time – nh, nh, nh – when I'm used to filling up the whole space, like in text messages I write 160 characters and not one less.

Second Interview, 2001, female, 28

Long messages could not be sent. The most serious and consistent difficulties with the Message Board were found when the users tried to send long messages to the message board with a WAP device. The browsers easily hang up when the user was in the middle of writing a message. Usually the user then lost the message that he or she had been writing. The phones did not give any indication

as to why the message could not be sent, and also the error messages from the server were not helpful.

> I just wrote a message w/ 600 characters to bird discussion. Disconnected while writing. When I tried to send again: Connection time-out!

Text message, 2001, male, 18

Many users wished to have feedback on whether the message was sent successfully. They would have liked feedback similar to the message that pops up after an SMS has been sent. They also had trouble finding the messages they had sent. After sending the message, they browsed back to the thread, which did not have the new message, because it was produced from the device cache. Reloading did not always help and the user had to re-navigate their way to the message from the main page.

9.1.2. Usefulness

The Message Board, in connection with the other services that were available, resulted in the interviews being inspiring and varied. All users gained some idea of what the service was like and how it could be used. One teen couple managed about 1200 messages during the trial, which promises great potential for this kind of service. In other groups, message threads gained around a dozen messages.

The following presents the observations that were made by the various groups regarding their communication needs, as well as how those needs relate to the Message Board. Usability observations have been reported in the previous chapter.

9.1.2.1   Birdwatchers

The birdwatchers' group consisted of five men, the youngest being 18 and the oldest 50 years old. They were all members of the same local bird club. They knew each other but were not close friends. A few of them sometimes went birdwatching together. The Internet experience of the group members ranged from novice to expert.

Communication. Every member of the group belonged to the mailing list of a local bird club. The club has home pages which are updated by one member of the group. Furthermore, they used e-mail and text messages in their hobby. However, their most important communicational channel was a national pager, which informs them around the clock of rare or otherwise interesting sightings.

The timing of the trial had its pros and cons as far as this group was concerned. In the spring and early summer, the birdwatchers are really mobile and thus excellent material for the trial. On the other hand, their being busy meant that they did not have much time to evaluate the WAP services.

Analysis. The members of the group were not close friends. The messages they shared were strictly informational and related to their hobby. They did not "socialise", share deeper information or private emotions.

After the test period, the members of the groups said that with refinement, a service such as the message board would be a good one for sharing bird observations. The worst deficiency for them was the lack of alarms. There should be an option to send real time messages to many recipients simultaneously. The WAP service would be even better than the current pagers if there was also a possibility to add a visual note or an audio clip to the message. The board could be a platform for identification of ambivalent bird observations.

On the one hand, WAP devices need to become more widespread for such a service to become usable by everyone in the birdwatcher group. On the other hand, the group has already demonstrated a willingness to buy various specific

and expensive tools for their hobby (pagers, GPS devices, a pair of field glasses, MD-recorders).

9.1.2.2 Choir members

The Choir group consisted of five active members of a choir comprising 30 to 40 members in total. The group included members who, to a large degree, handled co-ordinating and informing the choir of upcoming events, their schedule and the arrangements. Their ages ranged from 24 to 37; two of them were male and three were female. One of them had experience with WAP, the rest had very little if none. They were all experienced users of the web and computers.

Communication. The communication frequency between the choir members varies seasonally. Many concerts take place during Easter and Christmas, but there is little activity during the summer.

The choir uses a newsletter, a mailing list and a web site to inform its members of the various events. Communication with colleagues, especially abroad, is also handled by fax. The communication between the choir members, at least between the five in the trial, is mainly informative. Social communication is less frequent.

Analysis. The timing of the trial was not ideal in terms of communication within the choir. The major Easter events had already taken place and there was only one concert ahead before the summer, which did not require much co-ordination between the members. As stated before, the communication among the choir members revolved mainly around these events and not around social and/or personal issues. However, all members commented fluently on the conditions under which the service would be useful to them.

1) Proper communication calls for access for all members.

As a bulletin board for the complete choir, the service would need to reach as many members of the choir as possible. The choir already uses a mailing list, a web page and a newsletter for their communication, so the need for yet another channel is not great. On the other hand, it would be natural to add a service with the same principle as that on which their current communication is based: each member uses the service he/she feels comfortable with.

Most, although not all, members of the choir were already users of digital communication in one way or another, be it e-mail, web or mobile phones. One could imagine a core service, such as the message board, which the users could access by the means that are natural to them. Some users could read the web or messages forwarded to the mailing list, others could use WAP or read the messages as SMS. The service could provide a range of forwarding methods with different billing.

2) Mobile access to E-mail and messages.

Members pointed out that during holidays, their mailing frequency went down considerably. Some did not have access to the Internet at home. Especially during these e-mail slumps, a mobile way of checking e-mail or the Message Board could be in demand. Some users pointed out that a mobile way of checking messages could be more beneficial for users who are hard to reach through e-mail.

3) Calendar linked to the service.

Most members of the choir group noted that accessing their web page through the conversion could be helpful, because it contained the schedule for the choir. Other information on the site is quite static, but the schedule is current and at the core of how events are organised. Access to the web page through the conversion was deemed sufficient, but a package with a message service and a simple calendar could manage many of the user's needs in one go.

9.1.2.3   Expecting mothers

The **group of mothers-to-be** did not know each other before the trial. Their ages ranged from 26 to 36. They were all expecting their first child. They did not have any experience of WAP, but they roughly knew what WAP meant and contained. One member of the group was rather inexperienced with computers as well as the web.

Communication. Four of the mothers were selected through a discussion group on the web. The communication between them was solely through the web forum. The discussion includes women who are planning a baby, are pregnant, or have a child. The members also belonged to different e-mail groups, which are meant for those pregnant women whose due date is in a given month (heinämammat, elomammat, lokamammat). These discussion and e-mail groups were a way for these women to obtain information about their pregnancy.

Analysis. The communication between mothers consisted of sharing both information and feelings about children and pregnancy. The mothers felt that writing anonymously is one of the reasons that discussion thrives in their web discussion groups. The mothers, as all users, were registered under their own names in the Message Board and the group felt that this lack of anonymity, in addition to the small size of the group, affected the use.

The users' preferences for communication differed. One of the group members was not very familiar with discussion groups. She also said that she did not want to talk about personal things with strangers. Another user said that she got enough information about pregnancy from an e-mail group she had joined. She said that if the users were all at the same stage of pregnancy, it would be easier to have a conversation with them. Other users added that the discussion topics should be more specific.

To some extent, reading and sending messages to the message board was too difficult and this affected the users' activity. The users wanted to receive an alert when a new message had arrived on the Message Board.

> You get frustrated, though, like I'm there almost daily to see if there's anything new. I would reply to some of the messages, but I got to have 20 minutes to write the reply and I can't be at all sure if the phone's going to get all difficult and then I'll loose my patience.

Second interview, 2001, female, 28

Pregnancy and childcare are topics, which benefit a lot from peer-to-peer communication. This area covers both informational and emotional communication. If the user does not have Internet access, or connecting to it is too difficult, a service such as this can be of great value. The chosen test group was expecting mothers, as testing a service and being interviewed takes time. Obviously, parents of new-born children do not have time for long use sessions. Even more so in this case than with other test groups, the service needs to be easily accessible and quick to browse.

9.1.2.4   Teens

A group of five **teenagers**, four 16-year-old girls and one 17-year-old boy, took part in the trial. The group was put together by one of the female test users. All the girls of the group were in the same form at school. All members of the group had owned a mobile phone for some years. Each member also had an e-mail address but they did not use e-mail actively. Instead they sent several text messages daily.

Communication. During the field trial, the group became differentiated into communication pairs through their own choice. The dating couple that had already been together for several years formed one pair among themselves. The second pair consisted of the two best female friends. The girl who had put the group together and the girl from the dating couple formed the third communication couple. The mobile communication during the field trial concentrated mainly inside these pairs. Internal mobile communication between the whole group remained scarce.

At the beginning of the trial there was only one discussion group for the teens. As early as the first interview, the girl couple asked if they could have a separate group just for themselves. The girls started to use it several times a day. The original teens' group was rather quiet. To be classmates was not a good enough reason to communicate via a mobile service. But there was an emotional bond between the girl couple, and it motivated them to use to service regularly.

The girls also sent messages to the board when they had a chance to meet face-to-face. They used the board for many other reasons, not only to inform each other about what was going to happen the next day.

Analysis. The teenage girls used the message board most innovatively. The main point is not the frequency of the usage or the great amount of messages they sent to each other (about 1200 messages between two girls during the test period), but the rich user-generated content they created. Self-generated material will be an important form of mobile communication in the near future.

The girls used the messages on at least three levels:

- **"Secret hideaway" – a virtual room**. The board was a closed privileged space "only for us". The girls talked about the WAP as a real place where they had a sheltered room to meet (Table 4). They said that a important feature was the security of the WAP. No one could even read your secrets without permission.

- **"Our story" – a collective mobile memory**. The recent history of the girls was saved through long message chains. The girls started to create a new culture in the messages, too. They gave funny nicknames to each other; the content of the last messages is not easy to understand because of the private jokes and insider language.

- **"Mobile diary" – self-expression and interactivity**. The board was not used for direct communication only. The girls used it also as they would have their diaries, i.e. to express their emotions or bad feelings late at night. They said they could write things that are impossible to say face-to-face. However, "the mobile diary" was not only one-way but was an interactive channel (Table 5).

Table 4. The Message Board was used as secret hideaway.

> **MGJGT**
> *YOUR HERE RIGHT NOW, AREN'T YA...? ANSWER ME*
> **Girl B**, *Jun 4, 2001 12:01:06 AM*

Table 5. An excerpt of messages from two teens using the message board. The names have been changed. The girls did not seem to mind the scrambled letters in the original Finnish messages on the left.

vÃ¤syttÃ¤Ã¤ meenpois ku meen nukkuun **Girl A,** Jun 24, 2001 1:38:42 AM	*Tired* *Gottago gotta sleep* **Girl A,** *Jun 24, 2001 1:38:42 AM*
JUST...x2 TÃ??..JOSKUS EES MÃ? EN OTA SUST SELVÃ?Ã?!:) **Girl B,** Jun 24, 2001 1:38:46 AM	*RIGHT...x2* *WHA??..SUMTIMES I CANT FIGURE YOU OUT MYSELF?!:)* **Girl B,** *Jun 24, 2001 1:38:46 AM*
aaah., kauniita unia,oman kullan kuvia, **Girl A,** Jun 24, 2001 1:39:27 AM	*aaah.,* *sleep tight,dream of your sweetheart 2night,* **Girl A,** *Jun 24, 2001 1:39:27 AM*
mÃ¤ soitan huomen heinoille kun on pakko, tuleex jenni tÃ¶ihin?? **Girl A,** Jun 24, 2001 1:40:24 AM	*i'll* *call heinos 2morrow, i have to, is jenni coming 2 work??* **Girl A,** *Jun 24, 2001 1:40:24 AM*
OK AP KAUNIITA UNIA....:) Ã?LÃ? ....!! **Girl B,** Jun 24, 2001 1:40:46 AM	*OK AP* *SWEET DREAMS....:) DON'T ....!!* **Girl B,** *Jun 24, 2001 1:40:46 AM*
JOO KYL JENNI TULEE!! **Girl B,** Jun 24, 2001 1:41:52 AM	*YUP* *JENNI WILL COME!!* **Girl B,** *Jun 24, 2001 1:41:52 AM*

Howard Rheingold [RHE01], who has studied virtual communities, has defined features of the future's mobile virtual communities:

- *Many to many, desktop and mobile, always on.* Virtual communities and the resources of the Internet are instantly available to people and their software agents wherever people are located - at their desks, in transit, at home.

- *Used to co-ordinate actions of groups in geographic space* - teenagers swarm in malls, young adults club-hop, activists mobilise on the street.

- *Game environments, social arenas, artistic media, business tools, political weapons* - like other virtual community media, mobile virtual communities will start with young people as a mean for entertainment and light social interaction, then diffuse into other institutions.

As Rheingold says, the new form of the mobile community seems to arise from the world of teenagers. Like in the case of the SMS, teens are social pioneers, innovators and early adopters of the new communication possibilities. The findings of the WAP trial tend to back this theory up.

9.1.2.5   All users

All 40 users constituted one large, heterogeneous group. At a later stage in the evaluation, one individual user participated in the Mother group because she was interested in the topic.

Communication. The group itself did not have pre-trial communication needs, because the group was made up for the trial. The mass of 40 users was assumed to generate some discussion but in the main, the study of group communication concentrated on the five smaller groups.

Analysis. In addition to the separate groups of five, all 40 users could access a group called "Pulinapalju" ("Chatterbox"). It became clear, though, that a general group such as this one did not generate much discussion among users who did not have much in common. Topics that were popular in this group were "What are your plans for Midsummer?", "Who are you people?". The topic that

seemed to unite the users was Midsummer Day. All had an idea of what they would do on that day. Afterwards there were other topics that started to catch on, only to find that the trial was already ending.

The message board had potential among users who enjoy exchanging e-mails. Most users said that if they used such a service, it would be within a small interest group or among a circle of friends. One user had a use scenario in mind already:

> Hey, this would be useful in replacing group messaging with SMS, at least Radiolinja has it. Like if you have a group of 40 you need to get a message to, it'll cost you 40 marks. But this [Message Board] would work in sending bulletins or something like that. If a group has an upcoming event or party or something of the sort you could send a message on it like "If you're going to come, send an SMS to me". And you could send questions or whatever to the board, if you had any. So that others could see the answers, too. This could work very well for notices and bulletins for a group.
>
> **Second interview, 2001, male, 20**

Most of the users had at least one idea of how the chatterbox could be used in his/her own life. Some female users would have liked a platform where they could chat with people whose situation in life was similar to theirs (farmer's wives; fellow students; mothers of small kids). One male user said that for a sporting coach, the Message Board could be a place to keep the parents of young football players informed. One grandmother thought that the board could be a neutral notice board for a separated family. For business users, within a company, it could be a flexible internal information system.

9.2. Other interactive services

9.2.1. E-mail

E-mail was a highly desired service from the very beginning. Younger users and users who use e-mail regularly at work were particularly keen on the e-mail facility, as were those who have an e-mail address but do not have Internet access at home.

Once mobile interfaces began to arrive, most e-mail users accessed their mail with a mobile-aware service, such as Sunpoint.net or Luukku.com. We tried to ensure that all those who wanted to read their e-mail could do so. Setting up the device as well as a service to read e-mails is not an easy task. Some users already had an e-mail account, which had a mobile interface; one user was able to access the web service of his NIC e-mail account through the conversion proxy. For others, we set up accounts through existing services. Unfortunately there were also Intranet-mail accounts which we could not access and eager mail readers were left without the service. Users attempted to use existing web services through conversion when proper mobile mail services were not yet available:

```
I tried to get into Hotmail out of curiosity -> no
access. I tried sending an e-mail by writing the
address on my front page, I was sure it wouldn't work,
but I had to try  ;)
```

E-mail 24.3.2000, male, 19

While many of the users complained that they were not interested in accessing news pages since this was available from so many other sources, the e-mail facility on the contrary was something that was not available to them throughout the day. Some users did not have a PC or the Internet at home and they considered a WAP phone less of an investment and less space-consuming than a computer (Figure 29). Compared with the investment that a computer represents, even a fairly expensive device can seem cheap:

> If I had a WAP-stick, I'd probably use it only to read my e-mail. Perhaps I won't be buying one after all. A palm device, like a communicator type of thing, would be quite another thing, of a different calibre altogether.

Field trial journal, 2001, female, 32

Users mainly read their e-mail or wrote short replies to e-mails. Starting a new mail from scratch was a rarer occurrence.

Figure 29. A mobile device can be a cheaper alternative to a PC for users who do not have Internet access at home.

Personal communication clearly motivated the users into action in a way that would not be possible with mere information services. There were users who would hardly have used their WAP device, had they not been able to read their e-mail. E-mail was also something that even novices very strongly associated with WAP, and they expected to be able to read their e-mail.

Communication with a mobile device could be particularly useful with the upcoming GPRS, when the services become available 24 hours a day. Users stressed that the price needs to stay reasonable even then. E-mail is the primary service for many users of the i-mode system, and it appears that the service has great potential with Finnish users as well.

9.2.2. Search engines

The Google (web) and Evreka (WAP) search services (Figure 30) were used extensively by quite a few users. Google was accessed a total of 180 times during the trial and Evreka was accessed 147 times. The users were surprised to see their WAP searches return so many items. The traditional WAP portals had hidden the fact that quite a number of WAP services are already available. A number of users were clearly more interested in finding information when the need arose than in reading news or e-mail. Using search engines is also a way to avoid guessing what the salient web address would be.
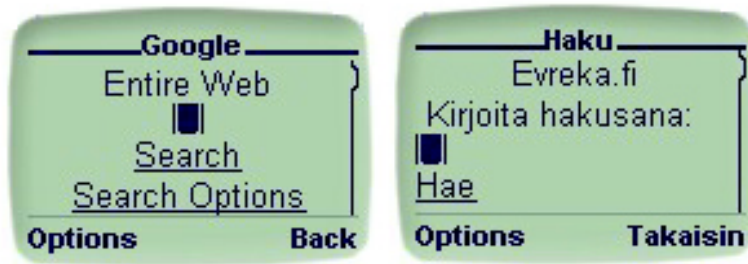
Figure 30. Search engines were found to be a very useful addition to mobile services.

With Google, the users would search for information on the web and have it converted for the phone. Google itself provides some conversion for the hits. Evreka was a WAP version of a Finnish search engine. With Evreka, the user could search through WML pages. These search engines, with their web counterparts, are thus a mix of mobile-awareness and mobile transparency. With Google, the interface can be mobile, but the access to web pages adds mobile-transparency.

It was clear, though, that a search engine needs to find information from the existing web, not just mobile pages. Users are not familiar with the content of WAP pages and feel more at ease when searching from the web. Searching from mobile pages is slightly more risky as there is less content than on the web. On the other hand, if a WML page on the topic is found, it is likely to be better formatted for the device. Unfortunately, quite a few WAP services failed to define the title of the page, thus giving no cue as to the contents of the page to the searcher.

In instances where the user does not know where the information can be found, the scales still seem to be tipped towards the greater content of the web than better formatting of mobile pages. Also, users feel unsure of the technical reliability of mobile pages that they have not already visited. In searches that did not require a broad sweep, such as for maps and phone numbers, the users favoured made-for-WAP services.

The users who were eager to search said that they looked for "small pieces of information". One user described how she used searches to settle arguments, while another searched for information on bus schedules and maps. One user described a typical situation where she would search for information:

> I've been searching a lot, like with Google. I use it in these little arguments that couples have. Like when my boyfriend was wondering when the tickets for the ice-hockey finals would come on sale and I said they're already sold months in advance, they are. He then said that "That can't be, people don't even know who'll be playing.". I said that that's not the point, I mean people...you can't book your trip to the game if you don't know if you're even gonna get a ticket. Of course they're sold in advance. So I checked, searched with a Google search for "World Championship 2001 tickets" and found Matka Kaleva, who were selling trips with tickets to all these last games on Saturday and Sunday. They sell them, all right, they're not gonna start selling on Sunday, that's for sure. So this is the kind of things I've been using it for.

Second interview, 2001, female, 32

There were several differences between these users and the ones who did not use searches. Users of WAP search engines were often more experienced with technical devices and were familiar with web searches. One key difference was that users who did not use the device for searches often said that they simply did not "think of it" or that they were "not used to doing it". This included technically experienced users as well. Often the "did not think of it" explanation was used in conjunction with other services that were on offer. Users who used searches in spontaneous situations were more likely to have integrated the device to a greater extent into their daily routine.

10. User Expectations and Profiles

10.1. How users viewed the mobile Internet

Due to the fact that the project extended over two years, we were able to observe the changes pertaining to mobile Internet services and their use (Figure 31). One could clearly see how the overall user perception of its early incarnation, WAP, changed within a year. At first, the majority of the users had only read about it, or were in the process of getting acquainted with WAP. The negative overtones of media attention were picked up by users who themselves had not had any experience of the system. Users who were acquainted with WAP were all too familiar with the limited content and technical unreliability.

Figure 31. During the trial, the users' view of the mobile Internet appeared to change from very media-influenced and critical to more experience-based and open-minded.

In the first trial, almost all users, including the ones with WAP experience, were critical of the system. Whether they had had experience or not, the perception was that WAP was mostly a useless form of entertainment, and difficult to use at that. In some cases, the media had set the bar too high:

> If they had presented it like, not with all this hype and hullabaloo, I think the view would have been more positive. It seems that marketing has promised things that the technique and current services cannot deliver.

Final interview, 2000, male, 37

Users felt that entering the appropriate settings to access WAP services was very difficult. The services, on the other hand were limited and difficult to use:

> The services there...in my opinion they are quite awkward and poor, I don't think they're good for much --- Just using them takes its toll.

First interview, 2000, male, 44

This perception was reinforced by critical feedback from peers:

> ```
> I met [an information scientist] for lunch. I showed
> her the device, but she wasn't particularly thrilled.
> "Looks   difficult,   such   a   small   screen,   too."   She
> associated WAP more with the vanities of the world.
> ```
> **E-mail 6.4.2000, female, 35**

Many users expected the services to be rather expensive. Time-based rate was seen as something which reduces the willingness to use the services. A monthly rate or a rate based on the amount of transferred data was considered to be fairer. The users were almost surprisingly open to the idea of lowering prices through advertising, as long as the ads were non-aggressive, e.g. simple links or logos on the pages. The ads should also be easy to avoid, i.e. no splash screens.

> It's kinda like someone with boots came through our door and asked: "Wanna buy fish?". Invades my space like that, I don't like it.

Final interview, 2001, female, 30

In the second trial, both novices and experts had a somewhat changed view of WAP. Their view also was, by and large, more positive and accurate. There were also users who were very knowledgeable about WAP and mobile devices after having used them. Some had developed a routine in using WAP and were not merely getting acquainted with it. The services that these people used were banking, news, weather and e-mail. They generally had quite a positive view of WAP.

Users that were new to WAP had some idea of what it was. Novices were slightly more aware of what WAP was and how it could be used. They mostly denied knowing much about it, but had roughly the right idea of what it could be:

> News, for instance. This you can get already as text messages of course, but I'd imagine they wouldn't be so short, stout and stiff but rather you could browse them on screen in some way. That's what I'm assuming one could do. Don't know, we'll see.

> **First interview, 2001, female, 32**

The quote above is interesting, because it describes quite accurately two aspects of how a lot of users perceived WAP. Firstly, it is quite an accurate description of how the services are structured, when compared to text messages. You get content, which can be "browsed on the screen in some way". Secondly, the description of the content is not far off ("news, for instance") and also indicative of the fact that users are not aware of specific services they could use. The exception to this rule is the e-mail.

Many users associated WAP strongly with news services and e-mail. They had a view of WAP as "something akin to the Internet" and e-mail was something that was a stereotypical Internet service. Users expected e-mail to be quite accessible with WAP. To be precise, they expected to be able to access their *existing* e-mail account with WAP. Creating a new account to access their own account was quite a foreign concept to them, regardless of the fact that this is how most current mobile e-mail services work.

Technical difficulties with the devices influenced the users' view of the technology. There were some very sceptical views of the technology among business users. Although unhappy about the difficulties, the view of the

consumers still remained mostly understanding. They expected the services to improve and diversify:

```
My car pool mate tried it and said that paying bills
with this would not be her cup of tea, it was too slow
(her bank had just marketed wap services the previous
day). She also said that in a year the situation might
be better, as with the Internet. In the morning
another car pooler looked for weather information and
was enthusiastic. Slow otherwise, she said.
```

E-mail 24.3.2000, female, 29

Four users had the opportunity to compare mobile web and WAP on a single device, the Nokia 9210 communicator. The test users of the Nokia 9210 were quite able to distinguish between the benefits of web and WAP, although choosing between the mobile web, converted web and WAP could be problematic:

> The differences between WAP and web seem to be somewhere in the layout and a bit with how longer pages convert. The errors seem rather minimal. Still, maintaining two similar technologies, is a bit puzzling. [..] If one technology doesn't work, you can always try the other one.

Field trial journal, 2001, female, 23

Limited content is an issue which has taken hold quite strongly. Users were slightly surprised to find out that the web could be accessed through the conversion proxy. Seeing one's personal pages on a phone was a thrill for some. At a later stage, the surprise of being able to access web pages had turned to surprise regarding the mobile content itself. Search results with hundreds or thousands of items was something the users had not expected of mobile content.

Despite a slowly growing awareness of what mobile Internet services can be, there were still over-expectations in both trials. In the first interview, many of the users said that WAP was a way to use the same services one can use on the

web. Actually, many expected WAP to incorporate the same features as the WAP conversion proxy.

10.2.   User profiles

In the course of the two-year study, the variety of WAP services became greater and after the deconstruction of the "walled garden" portals, it also became easier to access the new services. Users were better able to access e-mail, search engines and WAP services outside portals. Also, the improvements in the conversion proxy allowed better access to sites, login pages and even images.

The widening range of services led to an evolution in user profiles (Figure 32). As new services became accessible, the WAP user culture started branching out into more precise user profiles. In the year 2000, the user profiles were constructed with acceptance of WAP technology and its information services in mind. In 2001, communication and interactivity became very important dimensions in the user profiles.

Figure 32. More diverse user profiles begin to emerge with new services. While intererest in technology defined much of the profiles in the early stage, the latter profiles were defined with looser links to the technology itself.

In the 2000 trial we identified five different user profiles that describe the attitude of the users to the WAP services:

- For **Explorers**, the trial service was usually the only access to the Internet services. The Internet was a totally new, fascinating and extensive world for the explorers.

- **Amusement seekers** were interested in light entertainment ("fluff"), e.g., sites of popular soap operas, horoscopes, biorhythms, jokes, and so on.

- **Utilisers** started to regularly use practical services such as weather reports, banking services or up-to-the-minute news about the stock exchange.

- **Technology freaks** and **outsiders** did not find the WAP services very useful. The technology freaks had so many alternative ways to access the Internet already – both wired and mobile ones - that the WAP proxy could not compete. For the outsiders, the problem was the lack of interesting content.

As stated earlier, the aforementioned user profiles were constructed with quite a narrow range of information services at hand. The addition of a message board, e-mail and search engines led to more users finding the service that suited them the best. The strong acceptance of communication services in particular, led to an evolved version of the user profiles.

In the later version, we analysed WAP usage through two main dimensions: The first one was the need to *do* something (**transaction dimension**), and the second one was the need to *belong* to something, be part of a group (**social dimension**).

Both the transaction dimension and the social dimension can be divided into two parts, in which case the extreme ends are omitted. However, the poles of these parts are not so far from each other, as we will soon see.

These dimensions give us four separate lifestyles of users of the mobile Internet services (see also Table 6). We thus have users who are oriented according to **Advantage, Pastime, Communication, Joint activity and Life design.** We have also speculated about how the non-users of mobilse Internet services could be categorised.

Table 6. Different styles of using mobile services.

Need to do something *Transaction dimension*		Need to belong to a group *Social dimension*
A. Advantage-oriented **Information services.** Existing services made by content providers, e.g. stock rates, timetables, weather reports, news, bank services, search engine use.	**E. Life design –oriented** **Personal control over life,** e.g. shared calendar, user-generated contents, pictures, documents and photos Sharing of information and emotions.	**C. Communication-oriented** **Window to another life:** Observation "out" or participation "in" Chat-boxes, mailing lists, e-mail, text messages = now written mobile culture, tomorrow also visual material and audio clips.
B. Pastime-oriented **Amusement and recreation,** e.g. evening papers, horoscopes, joke services.		**D. Joint activity –oriented** **Amusement and recreation,** e.g. games with other mobile users.

Advantage-oriented persons (Figure 33) form a group whose members are usually considered "typical" WAP users, and without doubt most of the existing services are designed for this group. In our research, a number of business users were nearest to a typical member of this group. They want to do things quickly and precisely via mobile phones.

Figure 33. Current mobile information services cater to Advantage-oriented users.

Pastime-oriented persons are often avid users of entertainment services. Teenagers and people in their twenties are usually found in this group. Members of this group are often seen as heavily consumption-oriented people. A typical conception is that you can sell almost anything at any price to members of this group. Some of our youngest trial users had the characteristics attached to this group.

Figure 34. Teens were among the most communication-oriented of the trial users.

Communication-oriented persons represent the new communication generation. E-mail, chat and mobile phones are a natural part of their lives. It seems that many teens, but not all of them, could be placed in this communication group (Figure 34). They constitute a group which consists of pioneers of the new mobile community.

> I drove to Mikkeli and read my e-mail, my teacher had some last minute tips for my dissertation. And last Saturday we were out on the town, on our way to a baby goods store. I could check with wap, which baby seat had been recommended in one of the mails.
>
> **Second interview, 2001, female, 30**

It appears also that a number of *Outsiders* and *Explorers* that were recognised in the previous user trial, were now leaning towards this group. The communication group includes users who were not interested in anything *but* e-mail via WAP, i.e. former "outsiders".

Joint Activity–oriented and communication-oriented users are quite alike. Members of this group want to do something with others – playing games and having parties are typical activities for this group. They do not accept spoken or written communication just for the fun of it, without a wider aim. For them, mobile services are a new way of having fun in a social context, compared with landline telephones or mobile phone communication. Our field trial revealed one person who had all the characteristics of an average Joint Activity user.

Life Design–oriented people constitute a new group which is still only a reflection of what we expect it to be in the future. Mobile services enable members of this group to manage their lives socially (controlling large social networks) and temporally (working when you are away from the office). We predict that this will be an important user group in the near future. It is a hybrid of the other groups as well.

Potential users. There is still one group left whose members are not actually a group of users, but rather non-users of WAP services (Table 7). We named them "outsiders" in the previous trial. They can also be seen as potential users of the future mobile services.

> Somehow I feel I didn't use them [mobile services] that much. I realise there is a lot of stuff there, but I can't fathom what. Don't know what I would start using if I had one of those, would it be more like fun or news. Hard to say. What would be, like, my basic use, fun or something beneficial? it's still unclear to me.

> **Second interview, 2001, female, 28**

The typical outsiders were Internet novices and, slightly unexpectedly, many of the business users. Both user groups have the same basic problem. They cannot find services that suit them. In some cases however, there was some indication of the potential mobile services which could be aimed at this group, as demonstrated in Table 7.

Table 7. There were two kinds of outsiders.

Technologically-oriented outsiders	Novice outsiders
Net-oriented persons – heavy users of the Internet, always online at work and/or at home	Face-to-face oriented persons – usually Internet novices, too
Motto: *"I do not want to use WAP services if I cannot do exactly the same things with my mobile phone that I am used to doing on my PC. WAP is only an undeveloped way to be on the net."*	**Motto**: *"There is nothing a mobile phone can offer that I cannot do already. Besides I have heard it is expensive and difficult to use. I have just learnt to use the web. Why should I learn something new again?"*
Potential opportunities to use Fully mobile use when no chance to use a PC	**Potential opportunities to use** Semi-mobile supplementary use, sense of familiarity
Positive findings during the trial Private WAP, e-mail (without attachments), instant information: local bus timetables, weather forecasts	**Positive findings during the trial** E-mail, existing news services, easy to find: *"Just click and read"*, search engines: *"I have used this service on a PC and it works the same way here"*

We introduced a set of profiles that can be used to identify different user groups. While complete non-users are easily identified, mobile users cannot be placed solely into one of the six categories (Advantage, Pastime, Communication, Joint activity, Life design, Outsiders). Each user is a combination of two or three groups. Most of the teens are especially interested in communication services. In our trial, the teens also wanted to use news services, even though they considered news to be "boring". Some of the adults argued before the test period that the only interesting WAP service is the weather forecast. However, after the test period they were also keen on group communication services.

The main distinction with the earlier profiles was that communication came into play more heavily, whereas many mobile services concentrate on bringing information to single users. Users of information services can also be differentiated more precisely. The profiles that have been described above can also be used as a basis for personalising mobile services. Personalisation will be discussed in the following chapter.

11. Personalisation

Personalisation of software means making it more responsive to the unique and individual needs of each user. Personalisation may affect the means of interaction, the presentation or the contents. Personalisation can basically be implemented in services on three levels:

1. **Manual personalisation** – tools are provided to the user to adjust the services and suit the user's preferences.

2. **Profile-directed personalisation** – A user is either categorised into a group with an associated profile, or the user defines his/her own profile. This profile is then used to filter or structure information to meet the user's interests. The profile definition phase is still manual, but the application requires decisions based on the rules of the profile.

3. **Learning personalisation** – The system observes the user and is able to learn from his/her behaviour. The knowledge obtained from these observations is then used to support the user in his/her tasks. The learning behaviour can be complemented by user feedback.

In web services, the main aim of personalisation is to help the user find information in large web sites. All three kinds of personalisation approaches can be found, although the manual personalisation approach is still the most popular.

Yahoo! was one of the first sites on the Web to use personalisation on a large scale. The My Yahoo application was introduced in 1996. Udi Manber, Ash Patel and John Robinson describe their experiences with designing My Yahoo in [MAN00]. Since user data and bookmarks are stored on the server, My Yahoo is available and consistent no matter which computer the user happens to be using. Manber et.al. claim that usability is still the most difficult technical issue for large-scale personalisation. They stress that any personalisation feature should encourage experimentation. When people are not sure how things work, they are less prone to experiment for fear of getting to a state that cannot be undone.

The majority of active My Yahoo users do not personalise their pages. Manber et al. point out three reasons for this:

1. The default page is so good that there is no reason to personalise it.

2. The personalisation tools are so difficult to use that many people do not bother.

3. Many people do not need complex personalisation.

Manber et al. suggest that a major challenge for large scale personalisation is to lower the entry bar, making it easier for less-experienced users to customise their pages, and making it clear for novice users that customisation is possible. However, the power users should also be kept in mind, and their needs should not be underestimated.

There will always be tension between the use of personal data to improve the service for users and the use of the same data for commercial purposes. Sometimes these aims are mixed: for example, the users of Amazon.com appreciate e-mail messages pushed to them which contain details of new books related to the user's interests.

11.1. Personalisation in current mobile Internet services

Internet-capable phones have rather modest user interfaces. The usability of the services can be remarkably improved by adapting the contents and the presentation according to the user, the device and the context of use.

In current WAP services, personalisation is usually implemented as a web service, where the user can select personal links from a choice of alternatives. This choice is typically the list of the main items on the WAP portal. Since the choice is quite limited, the result cannot be described as truly personalised content. It is not easy to say how popular this kind of personalisation is since WAP itself is not very widely in use. However, not all users have easy access to the web, so for them, web-based personalisation is not a handy alternative. The users also have another alternative for personalisation. While being in a WAP service, they can apply bookmarks in a similar way as when browsing in the web. The bookmarks are available through the Options menu, thus not as easily available as the page with their own links.

In Japanese i-mode, the personalisation is done within the mobile service itself. The user can register different sites to a personal page, "My Menu", accessible from the i-mode front page. The user can also select "Add to My Menu" to add a link while accessing the service. "My Menu" can include up to 20 links. The latter approach does not require the user to actively start personalising but (s)he can proceed with personalisation as a sub-task while accessing the services. This approach resembles normal web usage, where the user can add the current link to his/her personal bookmarks. However, the links become more easily available once they are put into "My Menu".

Hollensberg and Vind Nielsen [HOL00] suggest that in WAP, personalisation is a highly advanced feature which WAP users will explore and use later, if ever. The first-time experience is always the non-personalised version. However, the authors admit that personalisation has great advantages and is a strong feature for the expert user.

On the other hand, Ramsay and Nielsen [RAM00] point out that lack of personal and localised services constitute very significant failings in WAP. They claim that apart from entertaining someone with time to kill, personal and localised information is where WAP should be able to make an impact. E.g., the capability of informing the user that his/her usual tube line has just been stopped should be a killer application.

11.2. Personalisation in the field trial

Personalisation was tested in both trials. During the first stage, personal links were added to each user by the researchers. In the second stage, the users could personalise their pages themselves, either on the web or with WAP.

Users did not have to personalise their links but they were encouraged to do so. Some popular and general links, e.g. a text version of the evening paper's web pages (www.iltalehti.fi/light/) were sometimes added ("push") by researchers. Usually links were added only for passive users but also some active users asked ("pull") that particular links be added. They may for instance have asked for "things to do with my hobby" or "some jokes". The editing of one's WAP page was consequently a form of manual "push and pull" of services.

Personal links on the user's front pages were popular from the beginning. Users felt that they were interesting and fun.

> Yeah, "that's the ticket!", I should say. There was new life on my pages the moment the dog and rabbit pages were added!!!

E-mail 26.4.2000, female, 29

The advantage of personal links was that the users could reach information that was not available by other means. One user read news about the town she originated from. None of this information was available in the newspaper of her current hometown or in teletext, let alone as a mobile service. Another user would read the homepage of his favourite baseball team.

Also, personal links had a socio-emotional component that was absent from general mobile services. The users found it exciting to be able to display the web pages of a friend or relative on a mobile phone. Displaying personal pages was a better way of demonstrating the service to friends than what was available otherwise. There was an element of status to the links.

The problems that were encountered with personalisation were mainly problems about finding the right, convertible, page:

> the problem for me has been to find decent sites with good information that are appropriate for this kind of use > there is a need for pre-personalisation through the web where you could transmit the links to the phone by air or something similar. Services that contain up-to-date information would be the most interesting, this is why I haven't found an interesting page for me yet, so for me at least the PC (net) is still competitive in its speed (search engines etc.)

E-mail 25.4.2000, male, 26

Online personalisation was tested in the project with the Link Editor software. In general, the service was simple to use and problems were few. Some of the users did use the editor quite actively, adding and deleting links. They also tested the note feature. The idea of the WAP note was that the user could write personal notes which were attainable everywhere.

Below is an excerpt of link editor usage by one active user (Table 8). Links include two newspapers, an employment site, a web diary and a pollen bulletin. You can see how the user adds a note "Remember to buy a curtain for the doorway" to the personal page and then deletes the link a few days later, presumably after the curtain has been bought. The user can also be seen to preview links on the web before adding them on the page.

Table 8. Example of link editor use. Some of the URLs have been abbreviated for the report.

Date	Action	Title	Content	Links
3.5.2001 8:36	Preview		http://www.iltalehti.fi/light	
3.5.2001 8:37	add link	Iltalehti	www.iltalehti.fi/light/2001/05/02/	5
5.5.2001 14:01	delete link	University	http://www.uta.fi/	3
5.5.2001 14:02	preview		http://www.uta.fi/[..]/paivakirja/2001/	
5.5.2001 14:02	add link	Kanerva	www.uta.fi/[..]/paivakirja/2001/	4
5.5.2001 14:03	preview		http://www.mol.fi/Tyovoimapalvelut/	
5.5.2001 14:03	add link	Jobs	http://www.mol.fi/Tyovoimapalvelut/	5
5.5.2001 14:03	preview		http://www.utu.fi/ml/aerobiologia/	
5.5.2001 14:04	add link	Pollen	http://www.utu.fi/ml/aerobiologia/	6
12.5.2001 17:01	add note	**buy!**	**toothpaste tootpicks**	7
14.5.2001 21:55	add note	**Remember**	**curtain**	8
20.5.2001 18:47	delete note	**Remember**	**curtain**	7
20.5.2001 18:49	delete note	**buy!**	**toothpaste toothpicks**	6
13.6.2001 15:42	add link	Hesari	www.helsinginsanomat.fi/teksti/	6

However, most users did not actively personalise their pages. A typical explanation for this lack of user personalisation was that the editing with a mobile phone was too troublesome, and when spending time on the net from a PC it was difficult to remember that you could also edit the links in your mobile phone. However, most of the users said that the idea of a link editor is definitely a good one. It is an applicable tool for creating a personal mobile portal when using WAP services for the first time.

These observations support earlier findings about personalisation, i.e. that users often express the need for personalisation and enjoy the personal links, but do not want to do much about it. This has been established in research, such as Nielsen [NIE98]. In our trial, we found that advanced users can be eager to test links and edit their personal page. Novice users often do not have an idea of which links they could use. With web conversion they may try pages which are difficult, if not impossible, to convert; with WAP they have little idea where to begin searching for content, even after instructions. Novice users simply use existing links and are careful not to venture very far from these links.

Lack of active personalisation can also be due to the novelty of the device and of mobile services. If the services are not integrated into the user's daily life and routines, there is little need to personalise. Existing links can already offer enough information.

If existing links are not sufficient, novice users (and even some experienced users) would be happier with selecting topics and be presented with a package containing relevant links that are guaranteed to work. For them, dispensing with URLs would be the best solution in general. These users could also be offered links as a kind of push service, if they so choose. However, if the user wants to add personal content, such as homepages of friends and family, writing in a web address is still the only option.

User profiles could be used more extensively to provide ready-made packages for mobile users. For instance, in the previous chapter we described five user profiles that were derived from the results of the user trial, **Advantage**-oriented, **Pastime**-oriented, **Communication**-oriented, **Joint Activity**-oriented and **Life Design**-oriented users. Figure 35 outlines a number of mobile front pages that would match with these particular profiles.

Figure 35. Existing User profiles can be used to offer new users a service package that best caters for their needs.

Not only do the selected services match the needs of the user, but also the information within these services is highly personalised, up to the correct bus lines and news. "My links" would complement the service with links the user has chosen personally to more obscure pages, such as a small local paper, hobby club, friends, bands etc.

The results of this study highlight the fact that mobile devices are above all personal communication devices (Figure 36). The WAP Proxy conversion brought WAP to a more personal level. With more options, users began to shift towards services that were personal and/or interesting to them. Also with general services such as news, people used the possibility to select their service provider. More attention should be paid in providing users with easy-to-use and effective personalisation tools.

From common to personal

News
Weather
Schedule
Tickets

My links
My e-mail
My files
My bus
My friends

Users feel that current mobile services are often inpersonal, faceless and difficult to reach. The mere existence of services is not reason enough to find them.

More elements from the user's life need to be integrated to mobile services. The device will become less of a technical tool and more a terminal to see the user's life through. Communication is one of the keys to true integration.
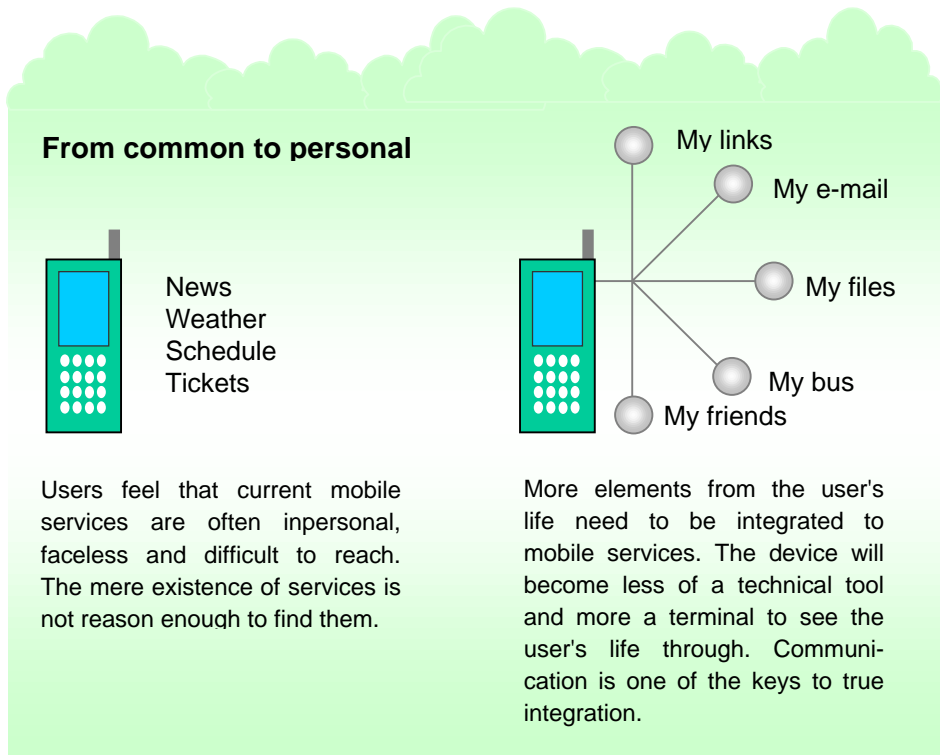
Figure 36. Mobile services are bound to match the personal nature of the device more deeply.

12. Service Providers' Point of View

In parallel with the user studies, we studied the acceptance of service providers by interviewing the representatives of current Internet service providers and probable future service providers. The aim was to study how these organisations plan to serve their mobile customers in the future and how the WAP conversion proxy would fit in with their plans. The interviews were conducted in two phases, the first one in spring 2000 and the second one in spring 2001.

12.1. Interviews in 2000/2001

Interviews in 2000. We started the interviews by first interviewing our co-operation companies (Alma Media, Decode (later Teamware Interactive) and Radiolinja). The themes of the interviews included mobile users and use situations, different kinds of present and future mobile services, personalisation, multimedia and adaptation of the services to different terminals. We collected their opinions and views regarding the kinds of organisations that would be interesting and useful to interview, as well as the themes for the interviews. The first interviews were carried out from February to March 2000.

The next set of interviews was carried out from April to June 2000. The interviews concentrated on content, users and production of the mobile services. We interviewed the representatives of 22 organisations. All interviewees were responsible for the production and development of the web and mobile services in their respective organisation. The themes of the interviews included mobile users and user segments, marketing of the services, different kinds of present and future mobile services, personalisation, multimedia, mobile portals and adaptation of the services to different terminals.

There were both private (14) and public sector (5) organisations in the sample. There were also three organisations of public interest. The majority of the organisations were from the private sector, since in the spring of 2000 the public sector did not yet offer any mobile services.

Service providers interviewed in 2000:

- Library of Aura (World's first public library which offered SMS service for customers)
- City Press (City magazine, Deitti.net dating service, chat service)
- Elisa Communications (Kolumbus portal)
- Meteorological Institute of Finland
- Infosto Mediat, Keltainen Pörssi (company which offers a service of classified ads)
- Instrumentarium, Optics (consolidated corporation which owns several opticians)
- Yellow Pages
- Kesko (franchising group)
- Matka-Kaleva (travel agency)
- Merita (bank)
- Mummon Kammari (club for elderly, public interest organisation)
- Pohjola (insurance company)
- Rakennustieto (publishing company for building trade)
- Riot Entertainment (company which offers entertainment and games for mobile devices)
- Shell
- Suomen Tennisliitto (Finnish Tennis Association, public interest organisation)
- Tampereen Messut (company which arranges/organises exhibitions)
- University of Vaasa
- Veikkaus (company which offers gambling and games for Finnish people, monopolistic position)
- Verohallinto (tax authorities)
- VR (company which is responsible for Finnish railway traffic)
- Population Register Centre of Finland

Interviews in 2001. In the interviews which took place in April-June 2001 we were able to demonstrate the conversion proxy service as well as the demonstration services (Message Board and Link editor) to the service providers. The services were demonstrated with the Nokia 9210 communicator and the Nokia 7110 WAP phone.

We studied whether the service providers wanted to offer their web services as converted, and what possible new ideas and views they might have about the conversion proxy service. We demonstrated how the service provider's own web services converted to WAP services.

The themes of the interviews included present and future mobile services, personalisation, content production process, discussion groups or virtual communities, multimedia, adaptation of the services to different terminals and image conversion. Finally, we demonstrated the Message Board and the Link Editor to the interviewees and illustrated future multimedia services by showing a video clip with the Nokia 9210.

Eleven organisations were interviewed as a whole. All the interviewees were responsible for their own organisation's web and mobile service production and digital content development.

Both the public and private sector were still included in the sample. There were four public sector organisations and six private sector organisations. There were also a couple of associations of public interest in the sample.

Service providers interviewed in 2001:

- IFI (photo laboratory)
- Infosto Mediat, Keltainen Pörssi (company that offers a service for classified ads)
- Kesko (franchising group)
- Library of Aura (World's first public library which offered SMS service for customers)
- Mummon Kammari (club for elderly, public interest organisation)
- Rakennustieto (publishing company for building trade)
- Tampereen Messut (company which arranges/organises exhibitions)
- University of Vaasa
- Veikkaus (company which offers gambling and games for Finnish people, monopolistic position)
- Verohallinto (tax authorities)
- Population Register Centre of Finland

12.2. Attitudes in spring 2000

All the companies were providing web-services for consumers, and half of them provided mobile services as well (WAP and/or SMS services). In the spring of 2000, the mobile services that the interviewed organisations offered for customers were mostly information or search services. The first WAP services were provided on the portals of the teleoperators in a "walled garden". The general climate at the time being was exciting and full of expectations. Service providers considered that the development in the mobile world was happening fast and that it was important to take part in it.

Plans for future mobile services. Interviewees were asked to express their views about potential mobile services in the future. It appeared that most of their visions consisted in interactive services. The service providers were also interested in location-based services but the idea of such services still appeared quite distant. The service providers seemed to be well aware that information services alone would not be enough, and that customers would require more interactive services in the future. Favouring mere information services may have affected the modest success enjoyed by WAP services in general. Services that were more interactive would have brought the idea of a mobile Internet somewhat closer to the user.

Multimedia. The service providers considered that images and audio would constitute the most interesting multimedia elements in future mobile services. Audio was especially mentioned as an important element, particularly in services that contain some kind of instructions for the user. In general, the service providers took a very positive view concerning the use of multimedia in mobile services. However, interviewees saw that mobile devices needed to be considerably developed before multimedia could become widely available.

User segments and marketing of the mobile services. Most of the service providers had not segmented their customers (users of web and WAP services) into specific user groups. The organisations that had used segmentation did it on a very general level. Overall, it seemed that the service providers did not posses a great awareness of what kind of users accessed their web and mobile services. At the time of the interviews, most WAP services were more or less

experimental. The services were designed mainly for early adopters of WAP devices and services, without a thorough analysis of this particular user group.

There was not a lot of marketing effort put behind mobile services to make them better known among users (even though most service providers had marketed their digital services on some level at least, for example by using commercial banners on the Internet). One of the reasons for this was the fact that marketing is quite expensive and demands resources. Under the circumstances, the marketing campaign put in place by service providers with limited resources was quite modest. On the other hand, when a teleoperator was marketing its own portal, service providers who had mobile services in that particular mobile portal got marketing support for free.

None of the service providers had marketed their mobile services separately. Most service providers did not consider this necessary. All the marketing efforts had been focused on the whole service concept. More extensive marketing efforts might have increased the use of WAP services in the year 2000. It is possible that limited efforts on marketing in general resulted in poor awareness of mobile services among users.

Pricing of mobile services. Service providers thought that the pricing of mobile services was troublesome. Service providers did not want to depend on the teleoperators because mobile services were considered to be quite expensive for the end users in that way.

> The costs of using (mobile) services are way too high for the user. It slows down the development.
>
> ..
>
> Offering services only for the elite is not the way these things are seen within communities. They have to be on offer for everyone.

Personalisation. Because of the personal nature of the mobile phone, service providers expected users to want personalised services. However, especially in the spring of 2000, it was not clear how this personalisation should be achieved. Web services were considered the easiest way to personalise the content for the user. The mobile terminal itself was considered to be the second best option to achieve personalisation. The bookmarks in the mobile device were seen as the

only option to achieve personalisation in 2000. Bookmarks were expected to remain an important way to personalise in the future. One of the service providers also suggested that some kind of a personalisation tool with a preview possibility would be useful.

Some general quotes about personalisation:

> A hybrid of information self-generated content and information that is collected and provided by the service provider would be a good solution.
> ..
> The personalisation methods depend on what and how much the user knows about the available (mobile) services.
> ..
> Different solutions work for different user groups.

Mobile portals and device adaptation of the services. The service providers said that they could not commit to the portal of a single teleoperator since their customers use different teleoperators. They also thought that having the teleoperator between them and their customers would hinder their contacts with the customers and make their brand less visible.

The majority of the service providers had not thought about adapting their services to different mobile devices. They were relying on device manufacturers to agree on suitable standards. Most service providers expected that there would soon be a demand for mobile services. They considered the concept of an automatic conversion and adaptation proxy server useful, but mainly with regards to free services. For commercial services the approach was seen as too indefinite. However, service providers hoped that they would not have to create the same content several times in the future. They hoped that some kind of automated system would be able to do the adaptation and scale the services to different terminals.

12.3. Attitudes in spring 2001

Compared to the expectations in 2000, the attitudes of the interviewees in 2001 were somewhat more reserved. The representatives of the relevant companies

said they would be ready to provide mobile services as soon as they could see a realistic business model in the field. New network technologies and devices would be needed on the market before this happened. In this situation, the interviewees were quite interested in the conversion proxy solution and anxious to see their own web services converted.

The small enterprises, organisations of public sector and public interest regarded the conversion proxy approach as quite attractive. They expected that they would not be able to provide separate mobile services in the near future. Constructing separate tailored mobile services demanded too many resources. There was also little certainty about which technologies to rely on in the long run. For example one service provider considered that WAP might be a transient protocol.

Most of the service providers were not interested in maintaining a proxy server of their own. They were more interested in the possibility that some other actor would do it for them.

Mobile services and contents. In the sample there were only two organisations out of eleven that offered WAP services and two organisations that offered SMS services. The ideas for new digital services derived usually from the producer's point of view and followed the service provider's own views and interests. One reason for this is probably the fact that users do not always know what kinds of services or technologies they might need in the future. In general, service providers did not have a definite view of content production as a process. However, one of the large-scale private sector companies described a content production process as follows:

> We go through parts of our business as a process. If we realise that there is a spot in the process where the use of the service demands a mobile service (e.g. a person on the move needs this piece of information), we go through the concept and extent of the service. If we notice that there is a need for a mobile service and that the service can bring added value to the whole chain of actions, we start to figure out what the future appears to be, the different options that we have, what service providers and suppliers exist and what are the costs of the construction (and also the pay-off period). If it seems that all the previous conditions are fulfilled, the concept is implemented.

In general, all the interviewees took quite positive views regarding mobile future. One of the interviewees stressed that at some point every organisation would have to start thinking about offering mobile services.

What do service providers want to convert? Seven organisations were interested in converting at least some part of the content of their web service. Surprisingly, a lot of interest was shown towards a light version of the web service. The idea was to generate a separate, lighter version of the service for the conversion. Some service providers considered that a light version of the web service should consist mainly of text based information. The service providers said that the mobile services that they will be charging their customers for should be constructed as tailored mobile applications.

Some service providers were also interested in converting Intranet and other internal web services. A couple of organisations were interested in internal discussion groups that can be used by the staff of the organisation in question.

The organisations interviewed were very eager to test how their own internal nets converted for mobile use. It appeared that the following issues were quite troublesome when web services were converted into mobile services:

- Several service providers wanted more functionality for their converted web services. In particular, web services based on databases were highly appreciated. Service providers pointed out that most of the organisations offer web services that utilise databases.

- Search engines were also hoped for so that it would be possible to use databases.

- Service providers wanted scripts to be converted. They wanted to offer services in which the user can <u>do</u> something, not only <u>read</u> information.

- Authentication is typical in Intranet services and thus it is important that the conversion should cope with it.

- A lot of material is provided in pdf format and thus impossible to convert.

- Image conversion was also considered a very interesting service and many service providers hoped that it would improve in the future. Especially e-commerce was an interesting area that would benefit from image conversion.

Brands in a mobile service. One of the companies brought out an interesting idea about taking brands into account in mobile services. In practice it could be done by using suitable logos, photos, highlighted texts etc. so that the user would feel more comfortable in using a familiar service.

> Our service is a brand and if it appears in the new Communicator only with black and white or blue links, something is missing. The aim is that the service somehow always looks the same, no matter what the device in question is. The brand should always be there, whatever the device. This is an issue that is usually forgotten or dropped out. People just think: let's convert it and we'll have a list of links on the phone's screen and so on, but of course a user is connected to the brand and an image of a service. He has a feeling of what the service is.
>
> ..
>
> In principle, branding could be easily taken into account in constructing (web) pages and converting them. It could be checked how we define that a logo should be shown etc. We could bring some elements of the service that affect how the service looks like in a mobile environment. It probably requires extra definitions, like take this element from here etc. However, it (branding) could be done quite easily and it is also an issue that should be considered at some stage.

In general, many service providers were quite interested in instructions and rules in constructing convertible web services. On the other hand, some service providers thought also that the converted service should be of good quality. They were not entirely satisfied with the appearance and functionality of the converted service. One of the interviewees stressed that public content should always look like it has carefully been thought through.

Personalisation and Link Editor. Most of the service providers could not comment much on the Link Editor because the service was completely new to

the interviewees. However, they though that the link editor was a good service and personalisation of the mobile services is a very important thing to achieve.

> There are also people who want to personalise. Not everyone is interested in it, but the people who are should be given a chance to do it.

Service providers also considered that personalisation via both web and WAP is useful to the user. Some service providers said that it is a good solution to let the user choose their own way of personalising

The Message Board was also demonstrated to the service providers. They took quite a sceptical view towards discussion groups and other virtual communities:

> We have had a couple of discussion groups and even at this moment we have a discussion group on our web site. Three posts have been sent during the last six months and they were all sent by ourselves. There hasn't been any need for a community for this group and the way we work.
>
> ..
>
> The difficult question is how you can generate actual business with discussions, e.g. what is the subject, in what way are people having conversations etc. In the entertainment sector there is certainly some need for discussions but it's very difficult to figure out any useful service around the issue. Are they (discussion groups) really used a lot?

Multimedia. Most of the service providers could not figure out any useful services that particularly needed some multimedia characteristics. This was a bit of a surprising reaction compared to 2000 when almost all service providers were quite excited about multimedia in mobile services in the future. In 2001, multimedia was considered as a nice little extra in a service. It also requires quite a lot of bandwidth. Before an extensive use of multimedia, service providers again saw that mobile phones should be developed considerably further.

However, some service providers had ideas about using multimedia, for example in better product demonstrations. One of the companies considered content production from the customer's point of view:

> The customer produces the content. Then the customer is the one who puts the product presentation onto the web in the way that he/she wants. Ads with photos are already a huge advantage. A customer should also have the possibility to produce such content (multimedia). Of course, the customer has the motivation too, because he/she is the one who is selling or buying something. But it does not start with us (offering multimedia services), it starts with customers. Ads with photos are chargeable in magazine, plain ads are free.

Image Conversion. The image conversion was demonstrated in a photo laboratory. The most interesting idea that came up in the interview was combining a digital photo album with a mobile device. The mobile phone could function as a "remote control" for the photo album and the user could do various operations on it:

> E.g., In a digital album it's possible to make a genuine postcard from photo number 5 by using a mobile device so that the postcard comes to your letterbox.

The first impression of the interviewees regarding photo conversion was that the converted photos were good enough to be used in a digital album's "remote control":

> The quality of the (converted) photos is good enough for the user to select an operation for the image, not so much for viewing itself.

Another interesting idea was using digital photos in various products. A user can take a photo by using a mobile phone in the future. Then he/she will be able to send the photos to a photo laboratory and order a mug, T-shirt etc. with the new photo on the product. This idea could have quite a good business potential in the future.

There will be very interesting photo-related products in the future. E.g. a user can choose which photos he/she will deposit in a digital album and order a mug or mouse pad from one particular photo. There are not many limitations on where the photos can be used.

12.4. Changing climate for service providers

Within the year between the two studies, the attitudes of the service providers towards mobile services changed considerably. In the year 2000 there was a lot of "hype" in discussions about WAP services. Most of the interviewed companies were quite enthusiastic and excited about WAP services and made plenty of plans for the future. In the spring of 2001 there were not that eager anymore. Interviewed companies had quite realistic views about mobile services and a mobile Internet in general. The representatives of the relevant companies said that they would be ready to provide mobile services as soon as they could see a realistic business model in the field. Before that, new network technologies and devices would be needed on the market.

It is obvious that there are still a lot of interest and expectations towards the mobile world. It was quite clear that service providers have not been satisfied with the present WAP services and technologies and they are looking forward to new technical solutions. This was possibly one of the reasons why they were so curious over the conversion proxy service.

In the long run, it is not very likely that service providers would be satisfied with offering their mobile services only via a proxy service. It is more likely that they could offer some of their mobile services through conversion, and some services as tailored mobile applications. These two ways of producing mobile services do not have to be mutually exclusive. They can both be used successfully depending on the purpose and the income of the service in question.

Service providers also seemed to prefer conceivably wide markets for customers. Free access to every mobile portal was considered to be an important factor. In practise this would mean that users should be able to use all mobile services. This kind of thinking supports the idea of conversion, which is more related to the idea of a mobile Internet than tailored mobile applications. Also, location

based services and different kinds of push services were considered to bring out a lot of interesting possibilities for future business.

Small enterprises, public sector and public interest organisations are the most suitable target groups for the proxy service because of their lack of resources in constructing mobile services. The conversion proxy service also gives organisations of this kind a chance to offer mobile services for customers. Otherwise these organisations whose resources are limited could be left out of the development of mobile services.

Large-scale enterprises may already have some kind of a mechanism that sorts out a structure and content of the service for different kinds of mobile terminals. In this way the content that has already been produced once can be used by different kinds of terminals. However these mechanisms do not necessarily take into account the wide variety of different mobile terminals. The WAP Proxy service can also convert general WAP content to make it more usable with different mobile terminals.

An interesting future research topic would be making brands visible in mobile services. How can a user recognise a familiar service on the screen of a mobile phone when he/she has seen the service in question before on the Internet? Are service providers going to support this kind of thinking in the future?

For the future development of the proxy service it will be interesting to research further issues related to the content production of mobile services. Are the service providers going to support the user's own content production? Which new kinds of services will be planned for the market when the technology evolves?

13. Conclusions

The project successfully designed and implemented a web conversion and adaptation proxy as well as personalisation and communication tools. These services were evaluated and used to study the way users reacted to various concepts of the mobile Internet.

For the provider of the conversion service, the proxy provides several parameters to control and fine-tune the conversion and adaptation. Many of these are properties of the requesting user agent (UAProf). The other parameters include system default options, user preferences, and device class specific parameters that can be altered to configure the system operation.

The evaluation of the proxy showed that most pages will convert, which is a very promising result. By following web accessibility guidelines, content providers can ensure convertibility. The biggest obstacle for conversion were complex front pages, which were both challenging to convert and difficult to navigate.

The LinkEditor tool that was developed for personalisation was an example of an application which produces separate interfaces for web and WAP use. This approach has shown to be very promising, as it can utilise overlapping functionality.

For the users, the availability of web content brought WAP to a more personal level. With more options, users began to shift towards services that were personal and/or interesting to them. They could also select the content provider they preferred, not only the one that had a mobile service.

The implementation of WAP communication services was a vitalising factor in our trial. Personal communication services seem to be somewhat underrated, considering the way in which WAP devices and services are currently designed and marketed. Some users prefer to use mobile services for communication only. Self-generated content and peer-to-peer communication should be seen as a more integral part of mobile services.

Freedom of choice. The user trials were a success in part due to the wide range of content the users had available to them. As a result of free access to the web and mobile services, new user profiles began to emerge. Communication and interaction were the main dimensions according to which the groups could be defined. During the project, information services were the main content of mobile content providers. The evaluation demonstrated that information from personally preferred sources as well as peer-generated content are more attractive than information targeted for everyone.

Mobile devices are usually secondary access points to the Internet for the users. That is why access to existing services may be more useful than new services designed specifically for the mobile environment. Future services will be designed for device independence from the very beginning. Meanwhile, the service providers regarded the conversion proxy as a good approach to providing access to the web services also for mobile customers and employees.

However, links should be targeted to exact pages and frames, since navigation through the converted material can be troublesome. Users widely agreed that conversion of web content for mobile use is something that should be developed further.

Personalisation is an important part of the mobile experience**.** For many, ringtones and logos have become an essential way to make the phone more to the liking of their user. However, when it comes to personalising content instead of appearance, the issue becomes more problematic. Users consider personalised content useful and even fun, but are not eager to perform it themselves.

While the task of personalisation may be too much to expect from new users, personalised content itself should still be available from the start. Otherwise, new users will not have much to keep them returning to the service.

To solve this dilemma, we presented user profiles which can be used to outline service packages for mobile users. They can be used as a starting point upon which the users can build their personalised service with the service provider. In addition to ready-made outlines, more attention should be paid to providing users with more finely targeted services placing less strain on the user.

Context. The field trial demonstrated that mobility at home has more potential than may have been expected. Much of the use took place at home in the evening or at night, while watching the television or even in bed. The presence of other media devices, such as the television or the Internet, did not prohibit the use of mobile services. In the case of the television, it even encouraged the use for some users. The results indicate that there is a natural context for interactive services that link mobile use and television. To define mobile services as something that will be used only while on the move, is to limit oneself.

In the midst of all the new technology, it can be difficult not to be blinded by it all. The results of this study indicate that mobile devices are above all **personal communication** devices. To serve a growing variety of users, targeted services are needed rather than a one-size-fits-all approach. Users need to feel that the services are in touch with their own lives. The personal, familiar and current will draw users in. In addition to information services there is a clear need for interactive services, where the users can participate and communicate with other people. The tools may change, but the needs of the users will not change for the technology.

14. Future visions

The variety of services and devices will increase. Mobile devices will be within reach for a growing number of users, which means that user heterogeneity will increase along with the array of services. Push services are just around the corner. Multi-modality with context awareness and location-based services are technologies which will open up whole new service concepts. Also, multimedia will come to mobile environments in force. The challenge of developing usable applications becomes all the more important and a very real success factor.

The support for personal cross-media content and peer-to-peer communication is an important key area for future research. Multimedia messaging services will provide a rich set of content in a messaging context where a mobile client is able to provide a messaging operation with a variety of media types.

New interaction techniques will be available. Multimodal applications will emerge where multiple channels (such as a particular user agent, device or modality) are simultaneously available and synchronised. The user may communicate and control the application via different kinds of alternative or additional input channels. For example, the voice browser of the device may manage voice input. The focus of interaction will range from using mobile devices as a remote tool to control the home or other environment, to using it as a simple vessel of information, that can be drawn from a number of sources.

Different modalities of mobility, such as personal mobility and terminal mobility, should be taken into account in application development. Thus, the properties of the transmission path as well as the terminal may vary a lot during the use. This all poses several challenges to application development. The applications should be scalable and adaptable to different contexts of use.

To control all this, it is in the best interest of both the service providers and the users to design services which are both easily adaptable and personalisable. The service provider will need to answer the demands of a dizzying array of devices, contexts and users. Conforming to each demand will need to take place as automatically as possible to be cost-effective.

One of the central challenges is the management of information overload. The users will need to personalise their services, if only to start making sense of it all. There are choices the users can take, which become understandable only in the context of their own lives. Users need to be provided with easy-to-use tools to make these choices. Personalisation and adaptation of services are the most promising factors in matching the service with the user and thus improving the usability of the services.

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Appendix A: WAP browsers

There are several different WAP browsers on the market. In our field trial we used browsers from Ericsson, Microsoft, Nokia and Openwave. The Openwave and Microsoft browsers are designed to be used in phones by different manufacturers, whereas the Nokia and Ericsson browsers are used in the phones of the same manufacturer. The browsers from the same manufacturer behave basically in a similar way but because the user interfaces of the phones vary, the implementations of the browsers on different phone models vary. In the following we describe the browsers that were used in our field trial.

Openwave browser

The most salient feature of the **Openwave browser** (Figure 1) is support for short cuts. Phones with the Openwave browser have a fixed Back key on the phone keyboard. On many devices this key also acts as a Clear key. This has the side effect that the user must delete the data in a query to retain the Back property. The labels for both soft keys are application programmable. The right soft key is the primary soft key and it is used for the highest priority action. Label Done is recommended on the secondary soft key for backward navigation greater than one step. If there is more than one secondary action, the label for the secondary soft key is Options, leading to a separate menu card with the optional actions. The recommended way to present menus for navigation is to use numbered selection lists. The user can use the number keys on the phone as short cuts to the different menu items. The navigation features adequately support wizard forms, and they are recommended to be used whenever possible. Skip label is recommended for going to the next item such as the next news article or next email message. If there is an input

Figure 1. The Openwave browser in Siemens C35i.

field on a card, the focus is by default on the first input field. [Openw01b].

The Openwave Browser is a software product used by many different phone manufacturers. Thus the implementation differs a lot on different devices. Display sizes vary from 2 lines upward. Links are displayed as [link], <link> or link. Some devices support left/right scrolling on the display and some do it automatically with periodically changing view. All browsers do not show the card title.

Openw01b   Openwave. Top 10 Usability Guidelines for WAP Applications.
                [online, cited 29 October 2001]
                http://developer.openwave.com/resources/uiguide.html

Nokia Browser

Figure 2. Nokia browser on the Nokia 6210 [Nokia01].

On the Nokia Browser (Figure 2), the left soft key is basically used as a positive key, containing actions such as Select, OK, Options and similar. The

right soft key is basically used as a negative key, containing actions such as Back, Exit, Clear and similar. The service developer cannot select the key labels but the labels correspond to the function currently highlighted on the display. In normal browsing situations the left soft key contains label Options that leads to a service options list. The service options list is a mixed list, containing both options for the current application and general browser options like bookmark handling and presentation options.

The call key (green phone) can be used as a shortcut for Select, otherwise select is usually twofold: Options/Select. With the Nokia 3330 the number key "1" acts as the short cut for selecting a link. Links, images and input fields are forced each on their own line, unless they are in a table. Menus are presented as lists of links. Accessing an input element on a form opens a separate card. The input elements on a form can be presented on the same card, or if a wizard type implementation is preferred, each input field must be put on a separate card with a link Next to the next card in sequence. In current Nokia WAP phones, left/right navigation on the screen and text emphasis are not supported.

The WAP browsers on different Nokia phone models are slightly different and the manufacturer provides separate WAP usability design guidelines for each phone model [Nokia01].
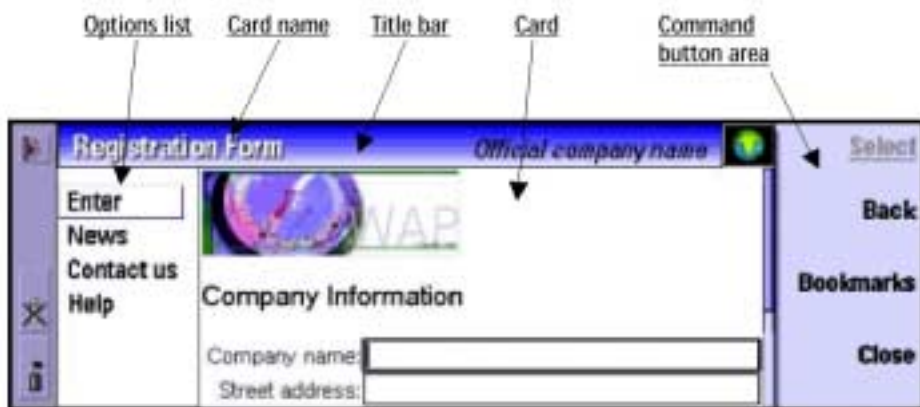

Figure 3. Nokia Browser for the 9210 Communicator [Nokia01].

The browser on the Nokia 9210 communicator differs quite a lot from the phone browsers because of the more versatile user interface (Figure 3). The browser includes both vertical and horizontal scroll bars to navigate on the page. The Options list is always visible on the left side of the screen. The focus is either on the Options list or on the card and can be switched with the Tab key. The links are navigated with cursor keys. Command buttons are shown on the right side of the screen. The browser supports all text formatting elements, tables, several types of images and colours.

Nokia01   Nokia Mobile Phones (2001). WAP Service Developer's Guides [several online documents for different Nokia WAP devices, cited 29 October 2001]. Forum Nokia. http://www.nokia.com/

Ericsson browsers

In the phones using **Ericsson browsers** (Figure 4), the Yes key is used to select items. The Yes key brings up the Options menu if no field is highlighted on the display. The No key is used for Back and Cancel. A dedicated C key is available for erasing input. Most phones include buttons for left and right navigation on the screen in addition to up and down. Left and Right keys can also be used in multiple selection lists to check and uncheck choices. In addition, the choices can be selected with the # key. Some phones have a dedicated key to open the Options menu. Text emphasis is supported. Select lists, Input fields and Options list are presented as overlay windows. As with the Nokia Browser, the input elements can be presented on the same card, or if a wizard type implementation is preferred, each input field must be put on a separate card with a link Next to the next card in sequence. In some phones, application specific access keys can be defined for links. Tables are supported in all phones. [Ericsson00]

Figure 4. Ericsson Browser on Ericsson R320.

Ericsson00   Ericsson. Mobile Phone R380. Design Guidelines for WAP
                  Services. Second Edition (June 2000). Ericsson Mobile
                  Communications AB. 2000. [online, cited 29 October 2001]
                  http://www.ericsson.com/mobilityworld/

MS Mobile Explorer

The Microsoft® Mobile Explorer™ (MME) includes dual mode microbrowser and is capable of browsing both WAP and Web sites. Also sending/receiving e-mail is possible through standard Internet e-mail protocols. The browser supports animated GIF, WBMP, and JPEG graphics [Microsoft01].

The browser contains a Home page (Figure 5), which includes the following links: select favourites, browse the web (here the user can enter a WAP or web site to browse), read email, write email and exit browser. The Home page also includes a link to the page that the user has defined to be the starting page in the WAP. Every time the user starts Mobile Explorer, he/she enters the Home page first.

Figure 5. The Explorer starts from a Home Page, where the user can choose bookmarks, browsing or e-mail.

The browser automatically adds the PREV-link at the end of each AP/web page, which takes the user back to the previous page. From the user's point of view, web and WAP are totally integrated in the browser. Links are selected with an OK button.

When the browser is on, the user can select the Info key -page, which includes actions such as page refresh, link to the home page, the possibility to add a page to the favourites, the option to make a phone call and to exit the browser. There is no separate Options button. Input fields are shown in the same cards as other

text, but editing happens in a separate field. Left/right navigation on the screen is not supported. Images, text emphasis and tables are supported.

Microsoft01   Microsoft Corporation (2001) Mobile Explorer. [online, cited 29 October 2001] http://www.microsoft.com/mobile/phones/mme/default.asp

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Title

Net in Pocket?
Personal mobile access to web services

Abstract

The diversity of mobile Internet services and devices is increasing. New services will reach a growing number of users, which means that user heterogeneity will increase. Providing device adaptation and personalised services is a major challenge when moving towards a device-independent web.

The WAP-UAPROF project (November 1999 – October 2001) was used to design and implement an adaptation proxy with capabilities for web and media conversion. Personalisation and communication tools were also implemented. The service was evaluated with 81 users in two separate field trials in 2000 and 2001. Profiles of mobile users were drawn from the results.

Free mobile access to web content brought WAP to a more personal level. With greater content, users shifted towards services that answered their personal needs. There was also a clear need for interactive services, where users could interact and communicate with other people. Context-wise, the field trial demonstrated that much of the use took place at home in the evening, rather than on the move.

The user studies were complemented with two rounds of interviews with service providers. The service providers regarded the conversion proxy as a viable approach to providing access to web services for mobile customers and employees.

The conversion and adaptation proxy server is a working solution to give WAP clients access to web services and to adapt WAP content for different devices. The results of the user studies stress the fact that mobile devices are above all personal communication devices. The most popular services included personal content and services, which provided users with new ways of communicating with other people. Targeted services, which coincide with the users' lifestyles, are needed to serve the interests of a growing diversity of users.

Keywords

WAP, i-mode, mobile access, usability, context adaptation, conversion, web services, personalisation