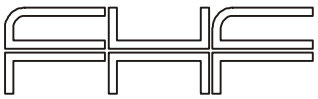
Smart Personalization for Wireless Applications

by

Matthias Hellmund

FACHHOCHSCHULE FURTWANGEN
HOCHSCHULE FÜR TECHNIK UND WIRTSCHAFT
UNIVERSITY OF APPLIED SCIENCES



Thesis (Diplomarbeit) submitted February 2003
in partial fulfillment of the requirements for the degree of

Diplom-Informatiker (FH)

Media and Computer Science
Department of Digital Media
University of Applied Sciences, Furtwangen, Germany

Matthias Hellmund
mailto:hellmund@mitbiz.de
Matriculation number: 823589
<http://www.mitbiz.de/diplomarbeit/>

1st examiner: Prof. Dr. Ullrich Dittler
2nd examiner: Prof. Dr. Wolfgang Taube

ABSTRACT

This thesis examines ways in which explicit and implicit user input can significantly increase the user experience with wireless applications. Because of the hard constraints in terms of displays, input/output facilities and networks, this is a particularly challenging task.

“Smart Personalization for Wireless Applications” takes a user-centered approach to discuss and evaluate different input factors and adaptive personalization techniques. Along a “Smart User Profile” which is being developed, the user’s benefits are demonstrated with practical examples. In addition to the conceptual parts, the thesis assesses and classifies relevant technologies across different layers from presentation languages to mobile operating systems and wireless air interfaces. The interdisciplinary view touching privacy, legal and security aspects is complemented by conceptual and implemented prototypes featuring multi-channel personalization techniques.

Smart Personalization is a promising concept that all key players in the mobile market can benefit from. However, it requires an interdisciplinary understanding and eventually a concerted effort of the whole wireless value chain.

0.1 Acknowledgements

I would like to thank Jan Michael Hess, CEO of Mobile Economy GmbH, Berlin, for his valuable support and input during the development of my thesis. Also I want to thank my examiners Prof. Dr. Ullrich Dittler and Prof. Dr. Wolfgang Taube for our straightforward cooperation. Special thanks goes to my brother Thomas, to Siliconavatar and to my flat mates for their nice comments.
And last but not least I would like to thank my parents for their love and support during my studies in Furtwangen and abroad.

Table of Contents

List of Tables

List of Figures

List of Code Examples

1 Introduction

Have you ever tried to read your email on your cell phone? How long does it take you to check a train connection on a WAP phone without a full keyboard? Many black-suited businessmen are telling exciting stories about UMTS and next-generation mobile services, but what is possible today? What are ways to make mobile applications more “intelligent”?

My final thesis “Smart personalization for Wireless Applications” tries to tackle these subjects from an interdisciplinary user-centric point of view. Apart from dark stories of intelligent machines like those told in movies like ‘The Matrix’ or ‘Terminator’, there are very interesting areas of application with “Smart Applications” being able to support the mobile users with the constrains of wireless networks and devices in mind. My thesis discusses some of these Smart Personalization techniques and technologies including their limits and possibilities and most importantly: including the user.

1.1 Focus of this Thesis

Reduced to a single sentence, my thesis boils down to the central question:

> *In which ways can wireless applications utilize explicit[1] and implicit[2] user input more intelligently for providing a better user experience?*

While in the purely academic sphere of research the answers would cover technically and economically inefficient practices as well, my approach is more focused. From the business side the following question will be asked: Can Smart Personalization techniques significantly increase the value of wireless applications for users? With my background as a student of media and computer science, which includes business and technological subjects, I try to combine these areas in examining eligible solutions including their respective constraints while developing a model of a "Smart User Profile".

1.2 Structure

After the introductory part including the central question I discuss throughout this thesis, chapter 1 introduces important key concepts and terminologies. Based on that the following chapter examines the overall picture of the mobile economy pointing out the user's role and the dependencies between different actors. Chapters 3 and 4 go deeper into requirements, difficulties and methods of resolution for enabling Smart Personalization in wireless applications. While chapter 3 gives a differentiated view on the conceptual layer, I tackle important current and future technologies involved in putting Smart Personalization into practice in chapter 4. Subsequently chapter 5 discusses an interesting prototype I have been developing during the thesis outlining some possibilities and constraints of Smart Personalization today. Chapter 6 concludes my thesis with a summary and a brief outlook on the evolution of learning mobile applications.

---

[1] According to Longman Dictionary of Contemporary English (1987), p. 355, "explicit" means "clear and fully expressed". Here "explicit" refers to all kind of direct user input.

[2] Longman (1987), p. 525, defines "implicit" as "implied or understood though not directly expressed". Here the term refers to all kind of data, which can be gathered without explicit user input, i.e. indirect input. Various examples will be given throughout the thesis.

1.3 Methodologies

An important part in developing my thesis certainly has been the traditional research including reading of various books, proceedings, journals and papers in university libraries and digital archives on the Web. Because lots of research activities are going on in the area of mobile applications and adaptive systems, many references are not more than 3 years old.

Other valuable factors in developing my thesis have been many interesting, controversial and fruitful discussions with my colleagues at Mobile Economy GmbH, Berlin[3], eventually having resulted in the prototypes I will discuss in more detail in chapter 5. Prototyping, implementing and testing was of special importance for covering not only the theoretical aspects of Smart Personalization for wireless applications but to understand the constraints, opportunities and difficulties that mobile application providers are facing today.

To participate in conferences and workshops organized by 'UMTS Forum'[4], FhG FOKUS[5] was useful for gaining additional up-to-date knowledge about the wireless industry as well as meetings and discussions with people from FhG FOKUS' Virtual Home Environment group, from University of Regensburg's institute for mobile business or from the German Research Center for Artificial Intelligence (DFKI), Saarbrücken[6]. In addition, I have been presenting the initial approach of this thesis as a position paper at ABIS-Workshop 2002[7].

1.4 Key Concepts

Before diving into the world of Smart Personalization for wireless applications this chapter introduces some of the key concepts and definitions. As some of the technical terms might be used with different meanings throughout different research publications it makes sense to define the "vocabulary" first. Additional

---

[3] More information about the company 'Mobile Economy GmbH' can be found at http://www.mobileeconomy.de/

[4] The UMTS Forum can be found at http://www.umts-forum.org

[5] Fraunhofer Institute for Open Communication Systems, http://www.fokus.fhg.de

[6] The DFKI also runs various projects in the area of wireless applications, http://www.dfki.de/

[7] ABIS ('Adaptivity and User Modeling in Interactive Systems') is a special interest group of the German Computer Society. Its 2002 Workshop was titled 'Personalization for the mobile World'. The online proceedings are available for download at <http://www.kbs.uni-hannover.de/~henze/lla02/abis_proceedings.html> [Accessed: 19 February 2003]

important terms will also be defined throughout the thesis. The Glossary section in chapter 8.1 contains a complete list of definitions.

1.4.1 Mobile Customization

In colloquial language, people often equate personalization with customizing their mobile terminal, i.e. its auditory and visual appearance. Most end-devices being available today offer customization options such as personal ring tones (simple beep melodies up to polyphonic melodies and recorded wave sounds), exchangeable covers and keypads, custom wallpapers and even screen savers. Another mobile fashion trend being more popular in Japan are the so-called keitai[8] straps, one or more small colorful straps attached to mobile phones, sometimes including a display cleaning pad. In addition, various gadgets exist such as call notification blinking lights, belt clips and many more.

While all these measures certainly reveal something about the user's personality, it is explicit customization and usually does not affect mobile applications. Although it would be interesting to use a mobile music site knowing about your currently installed tune or the interface of a news service adapt its design according to your currently selected color and icon theme, these use cases are more of theoretic nature than reality today.

1.4.2 Wireless Applications and Mobile Users

In my thesis I use the term "wireless applications" for applications being used on mobile devices, i.e. in environments with constrained network, display, memory, processor, battery and input/output resources. Although most portable computers would fit into this category as well, I will focus on applications in more limited environments such as PDAs[9], Smartphones and mere voice- and SMS-enabled mobile phones.

Mobile applications and sites[10] are often seen as "the normal internet without wires". But this direct comparison does not match reality very well. Although

[8] Keitai is the Japanese word for mobile phone

[9] Personal Digital Assistants (PDAs) are small mobile hand-held devices. Popular PDA operating systems include Palm OS and Microsoft Windows CE platform (also see chapter 4.3).

[10] Sites refers to browser-based applications. Similarly to webbrowsers many mobile end-devices have built in micro-browsers for accessing specific wireless sites or even regular web sites.

there are similarities such as the technologies employed (Java, C, TCP/IP, etc.) the context of use of wireless applications is usually very different from the use of fixed-line internet applications. Most importantly, the mobile users have to face very limited input/output capabilities of their devices due to their small form factors. Above all, the available network connections are usually are not only much slower but also more expensive than those of desktop online applications. In addition, mobile users act substantially different than fixed-line internet users, which makes some types of applications more and others less suitable for the mobile use. In fact the word "micro-browser", an installed or built-in application for primarily accessing specific wireless content, does not fit its current use very well.
We know from the fixed-line internet that people like to "browse" through various Web pages, probably with a couple of browser windows open on their high resolution monitor accessing broadband content through their DSL connection and without any pressure of time because of their flat rate. In the wireless world users in fact are more dedicated to finding specific information they are looking for facing the difficulties of mobile devices, applications and networks.

1.4.3 Wireless Usability

The ISO 9241-11 standard defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use"[11]. The definition provided by the Institute of Electrical and Electronics Engineers, Inc., (IEEE) underlines the learning aspect by defining the term usability as "the ease with which a user can learn to operate, prepare inputs for, and interpret outputs of a system or component"[12].
While both these definitions are very general, "wireless usability" is a special case requiring special attention. During the development of this thesis I have been asking different experts on their opinion what "wireless usability" is and if they think there is a difference to what could be called "Web usability". The answers I got were relatively diverse[13] ranging from "no differences at all" over "even more

[11] International Organization for Standardization (1998) *Ergonomic requirements for office work with visual display terminals (VDTs) – Part 11: Guidance on usability. ISO 9241-11*

[12] Institute of Electrical and Electronics Engineers (1990). *IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries.* New York, NY.

[13] For a compilation of the experts survey results see chapter 7.2.

important than on fixed-line internet because of strict device constraints" to the high claim "it should work while driving a car".

From my perspective, "wireless usability" applied to mobile applications as a matter of fact has to take the special mobile user context into account to facilitate users seeking for specific information without much browsing and enabling a high level of efficiency although being used in on-the-go situations. In their *Introduction to The New Usability* Peter Thomas and Robert D. Macredie see wireless usability also as a challenge for traditional usability testing environments as appliances "need to work in low-attention situations, or where the user's attention needs to be fleetingly channeled through the appliance—while walking, talking, or any of the multitude of other day-to-day activities that would be routinely classified as 'distractions.'". They claim that rather "than being 'edited out' of the context as they are in the usability laboratory, these features must be at the center of understanding and designing these technologies."[14] It might be this "specified context of use" as mentioned in the general ISO 9241-11 definition, that makes wireless usability interesting and challenging.

Back in December 2000 the Norman Nielsen Group, well-known as experts in the area of Web usability, published a WAP Usability Report from a Field Study in London.[15] In 2001, the first Mobile Usability Report[16] was published in Germany. Both reports showed very clearly that there is much room for improvement of wireless applications. "Fit Service to User to Device & Reduce to the Max" was the subtitle and bottom line of the Mobile Usability Report, the ideal case which Smart Personalization techniques can help to achieve in order to present

- the right information
- at the right time
- to the right user
- in the right format
- with the right interaction and navigation opportunities.

---

[14] Thomas, P., Macredie, R. D. (2002). Introduction to The New Usability. *ACM Transactions on Computer-Human Interaction*, 9 (2), June 2002, p. 71

[15] Ramsay, M., Nielsen, J. (2000) *WAP Usability. Dèjá Vu: 1994 All Over Again.* Report from a Field Study in London, Fall 2000. Fremont, CA, USA: Nielsen Norman Group.

[16] Duda, S., Schießl, M., and Hess, J. M. (2001). *Mobile Usability Report. Fit Service to User to Device & Reduce to the Max!* Göttingen, Germany: BusinessVillage.

1.4.4 Personalization

The Durlacher *Mobile Commerce Report* believes that personalization "is the difference between a usable application and an unusable application."[17] Other publications such as *Mobilex – Glossary and Abbreviations in Mobile Business* emphasize the business opportunities connected to personalization: "For wireless consumer applications, tailoring content based on individual preferences and need opens up new value-added opportunities for cross-selling related items and up-selling more expensive variants of the initial product of interest."[18] In *The Experience Economy* Pine and Gilmore go very far with their definition by propagating a holistic approach covering goods, services and experiences offered to the visitor. They argue that "companies can cultivate [...] a learning relationship with the guest, locking him in to coming back to the site every time he's in the market for something they provide. That's the way to create that elusive 'stickiness' everyone wants so badly, and (not coincidentally) the way to turn a mundane site into an engaging experience."[19]

While Personalization can definitely stimulate 'stickiness' or the usability of applications, I strongly deny an improvement automatism being associated with Personalization. A more pragmatic definition comes from Jakob Nielsen: From his point of view Personalization "is driven by the computer which tries to serve up individualized pages to the user based on some form of model of that user's needs."[20]

However, on the fixed-line World Wide Web, there did not seem to be an urgent need for navigational Personalization. On today's standard screen sizes such as 1024x768 pixels a Web site can present numerous navigation and interaction possibilities to a user, all within one field of vision. People would still find "their" choices in between and would simply "overlook" the uninteresting parts. Web users actually will most likely find it strange to see a website reduced to only a few but useful options on their screen. Wireless users, however, are hoping to find

---

[17] Durlacher Research Ltd. (1999). *Mobile Commerce Report*. November 1999, p. 67

[18] Junglas, I., Lehner, F. (2002). *MobiLex – Glossary and Abbreviations in Mobile Business (5th Edition)* [Online]. Available from University of Regensburg, Germany. <http://www-mobile.uni-regensburg.de/freiedokumente/Berichte/MobiLexEnglisch.pdf> [Accessed: 7 January 2003], p. 18.

[19] Pine, B. J. II, Gilmore, J. H. (1999). *The Experience Economy*. Boston, MA, USA: Harvard Business School Press. Chapter 4, "Get Your Act Together".

[20] Nielsen, J. (1998). *Personalization is Over-Rated.* Jakob Nielsen's Alertbox for October 4, 1998. <http://www.useit.com/alertbox/981004.html> [Accessed: 6 January 2003].

also this kind of personalization in mobile services. But not all types of personalization are suitable for wireless applications, as also the Durlacher UMTS Report emphasizes: "The traditional 'tick-the-box' personalization, that dominates wireline internet applications, is not likely to be sufficient."[21]

1.4.5 Smart Personalization

Therefore a more intelligent way of personalizing wireless applications is needed, an approach I will be naming "Smart Personalization". In the report of the same denominator, Forrester defines "Smart Personalization" as:

> *"Content and services actively tailored to individuals based on rich knowledge about their preferences and behavior."*[22]

A very interesting aspect about this condensed definition is that Forrester stresses the fact that Smart Personalization focuses on individuals in the first part. Device constraints and additional factors such as location data are important factors to take into consideration obviously, however the individual users and their preferences and behavior, their context, remain the key elements in comprehensive Smart Personalization efforts.
That personalization efforts should not be dependent on one single device is what Nielsen proclaimed in the need for *Supporting Multiple-Location Users*[23], of which the basic message is to offer personalization features to multi-device and multi-channel users, e.g. personalizing an application for users accessing the service from home and from their office.

Personalization with interactive applications (i.e. web applications or wireless applications) is not necessarily to the user's benefit when implemented poorly. So let us ask the question: "What is not really smart personalization"?

---

[21] Durlacher Research Ltd. (2001). *UMTS Report. An Investment Perspective.* March 2001. <http://www.durlacher.com/downloads/umtsreport.pdf> [Accessed: 15 January 2003] p. 79

[22] Hagen, P. R., Manning, H., and Souza, R. (1999). *The Forrester Report. July 1999. Smart Personalization.* Cambridge, MA, USA: Forrester Research, Inc., p. 8

[23] Nielsen, J. (2002). *Supporting Multiple-Location Users.* Jakob Nielsen's Alertbox, May 26, 2002. <http://www.useit.com/alertbox/20020526.html> [Accessed: 6 January 2003]

From the business side one could say that "not really smart personalization" includes those kind of personalization efforts that actually turn off customers. In his article *Personalization: Definition, Status and Challenges Ahead*[24], Kim differentiates between excessive and irrelevant personalized marketing efforts, which can be applied to wireless applications as well:

Excessive includes

- too many recommendations
- "bombarding" customers
- "encumbering" customers (i.e., requiring too many questions to answer)

Those problems can be the result of personalization done poorly, due to lack of consideration for human reaction to marketing.

Irrelevant includes

- inaccurate recommendations
- irrelevant recommendations

This is often the result of recommendations based on insufficient or erroneous data, or inadequate training of the data mining algorithms.

A rich knowledge about the user as proposed by Forrester[25] combined with "the emergence of intelligent personalization solutions that will be able to record and learn from the user's behavior patterns"[26] as foreseen by Durlacher can build a Smart User Profile, as I will discuss in chapter 3.

---

[24] Kim, W. (2002). Personalization: Definition, Status, and Challenges Ahead. *Journal of Object Technology*, 1 (1), pp. 29-40. Zurich, Switzerland: ETH Zurich. p. 37.

[25] Hagen, P. R., Manning, H., and Souza, R. (1999). *The Forrester Report. July 1999. Smart Personalization.* Cambridge, MA, USA: Forrester Research, Inc.

[26] Durlacher Research Ltd. (2001). *UMTS Report. An Investment Perspective.* March 2001. <http://www.durlacher.com/downloads/umtsreport.pdf> [Accessed: 15 January 2003] p. 79

2 Mobile Companies and Users

First this chapter takes a look at the bigger view, the meshwork and interactions of the companies constituting the mobile economy triangle. Then I discuss the user's position and views within the mobile sector as well as the role of Smart Personalization.

2.1 The Mobile Triangle

Strong interdependencies between the different players within the mobile economic sector exist and influence developments and revenues of all members of this meshwork. The major three entities in the wireless world can be seen as a triangle consisting of Networks, Devices and Applications. These are mobile network operators (MNOs), device manufacturers and content / application providers respectively.

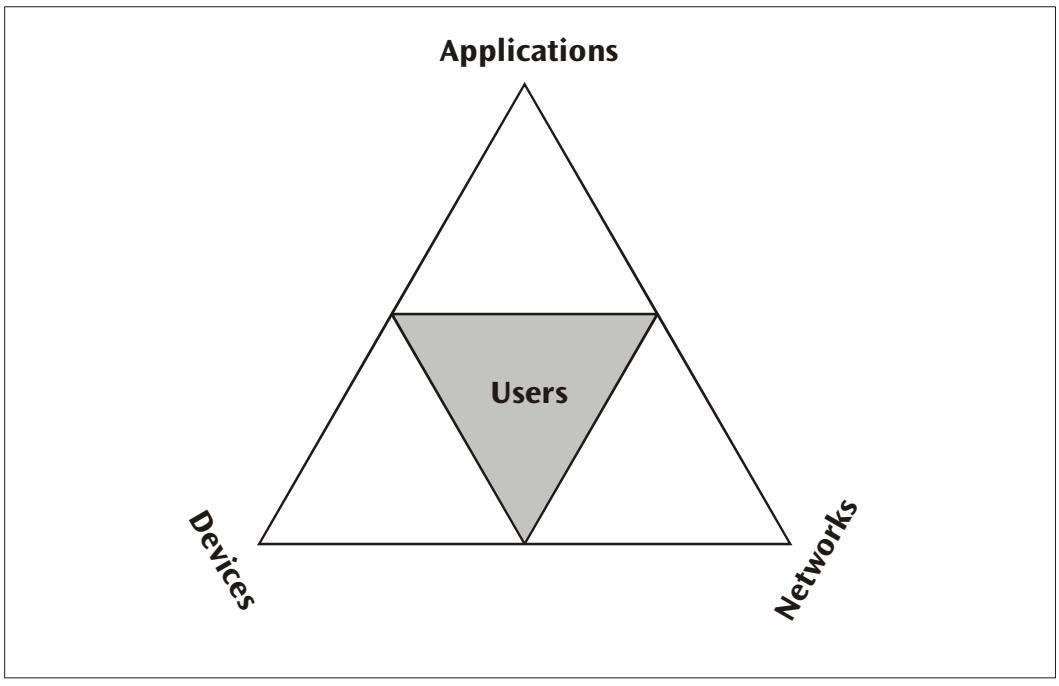


Figure 1: The Mobile Triangle

Each of these entities has its own target corridor which in some areas is in conflict with the aims of the other entities. In January 2002 for example, the decision of

the network operators to raise the SMS[27] prices in Germany clearly affected the application providers' abilities to offer services based on instant notification to a wide ranger of users. Many advertising-revenue driven services ran out of business. Device manufacturers such as Nokia integrated SMS "chat" functionalities in their mobile phones enabling users to send a couple of short messages to friends and keeping a sorted log file of it. The use of this function was clearly limited by the decision taken in the network corner of the triangle. Some people argue that the MNOs occupy a too dominant position within this triangle. In fact, in Japan the MNOs have taken an even more prominent role virtually dictating device manufacturers which features they are supposed to build into their handsets in order to still being acknowledged as compatible devices. Content providers are largely dependent on revenue sharing agreements with the MNOs who eventually hold the direct link to their customers. From their point of view, however, users perceive the combined result of the triangle as a mobile service. Their buy-or-deny decisions eventually affect the revenue of all players in the mobile triangle.
Eventually only a good collaboration between Networks, Devices and Applications will result in valuable services users are willing to pay for. This is also the reason why more and more alliances are formed such as those recently announced during the 3GSM World Congress 2003 in Cannes, France. Another development is that companies are trying to cover more than one triangle's corner, e.g. Siemens offering devices and services or T-Mobile acting as an MNO and application provider.

2.2 Success Factors for Mobile Applications

Simply said, success factors for mobile applications are properties making the customers return to use an application again and again. From the user's perspective these can be reduced to the three basic factors: Utility, Usability and Pricing:
Utility refers to the application being useful to the user. An application with a high level of mobile utility is particularly useful to users in mobile situations. Even

[27] Short Messaging Service (SMS) enables users to send messages up to 160 characters from and to mobile phones. The standard pricing for a MO (mobile originated) SMS in Germany is 0,19. The MT (mobile terminated) SMS pricing was increased in January 2002 to approximately 0,06. Also see chapter 4.4.5 and Junglas, I., Lehner, F. (2002). *MobiLex – Glossary and Abbreviations in Mobile Business (5th Edition)* [Online], pp. 19-20

mobile games do have a high utility to many mobile users, which could be either to challenge people or that they simply function as "time-killers".

Usability, as described in more detail in chapter 1.4.4, is seen as another important success factor. Findings of the *Mobile Usability Report* include that Utility (40%) and Usability (27%) belong to the influence coefficients concerning acceptance of mobile services[28].

Pricing finally is another important factor which users consider when selecting wireless applications. Both, initial costs such as download fees and usage costs such as subscription charges and traffic fees need to be in the right ratio to the value the user receives from a wireless application. As a result, many experts nowadays call for a value-based pricing approach for mobile services.

Smart personalization correlates with all of these three basic success factors with the potential to positively affect all of them. Applications which are intelligently personalized to the individual person's needs consequently offer a high level of utility to the user. Due to relevant recommendations included in the individually adapted user interface a higher degree of usability can be reached. Finally providing a personalized application to the users enables them to reach their goals better and faster thus saving expensive airtime costs. Therefore we can classify "Smart Personalization" as a solution path to optimize wireless application from the users point of view.

2.3 Conflicting Target Corridors

What is good for the user is not necessarily appreciated by all entities in the mobile sector. Initially MNOs would not be happy with the idea that optimized personalized services support the users in achieving their goals faster[29] thus resulting in reduced air time and data traffic per use. However, what also needs to be taken into account is that these measures can result in increased revenue and mobile Internet usage. These careful considerations were made by O2 Germany, for instance, when they decided to employ personalization techniques into their mobile portal.

A similar field of conflict can be observed in the mobile gaming sector. Device manufacturers and mobile game developers are trying to support the latest tech-

[28] Duda, S., Schießl, M., and Hess, J. M. (2001). *Mobile Usability Report. Fit Service to User to Device & Reduce to the Max!* Göttingen, Germany: BusinessVillage. p. 22.

[29] Also see case study on O2 ClixSmart Navigator in chapter 6.3.1

nologies in their products by launching adapted versions. The MNO thereby takes the role as a transport pipe charging for traffic (such as initial download and high-score updates) and for small parts of the subscription or download fees. While offering a Bluetooth[30] Multiplayer game through their mobile portal isn't of the MNOs' interest in the first place (they cannot charge for data traffic in local Bluetooth networks), it may be of a very high interest to MNOs to charge a critical amount of users for download fees and regular level updates through their networks.

While the MNOs' primary interest is to maximize their Average Revenue Per User (ARPU)[31], device manufacturers thrive to motivate device upgrades. The wireless application providers eventually try to maximize their revenues by increasing the number of users subscribing to their services. Although the individual goals and their strategies are different, one congruent target objective of all three main players in the mobile sector is to maximize the number of happy users. One important step to reach this objective is Smart Personalization, which requires an advanced level of collaboration and commitment to standards from MNOs, device manufacturers and application developers. Looking back to the beginnings of their company in 2000, ChangingWorlds Ltd. even summarizes that "it was clear at the time that personalization was a 'must have' for the mobile lifestyle to be realized and if the mobile Internet was ever to take off."[32]

However, a smooth conflict-free collaboration may sound like an ideal scenario, therefore the following chapters discuss in more detail the particular requirements and difficulties associated with Smart Personalization put into practice.

[30] Bluetooth is a short range radio communication standard discussed in more detail in chapter 4.4.2

[31] ARPU is a key benchmark in quarterly financial reports of the wireless carriers

[32] A brief history of ChangingWorlds Ltd. can be found at <http://www.changingworlds.com/sublevel.jsp?ID=2> [Accessed: 19 February 2003]

3 The Smart User Profile

A suitable user model is the core of all personalization efforts. The Smart User Profile I am developing throughout this chapter aims at modeling the user's context including technical aspects, identity, preferences, behavior and interests[33]. It serves as a data platform for personalization techniques applied in wireless applications while being developed and shaped over time. The Smart User Profile also includes derived and rendered pieces of data, implicit knowledge about the user's background and context which can be generated and stored by different personalization techniques.

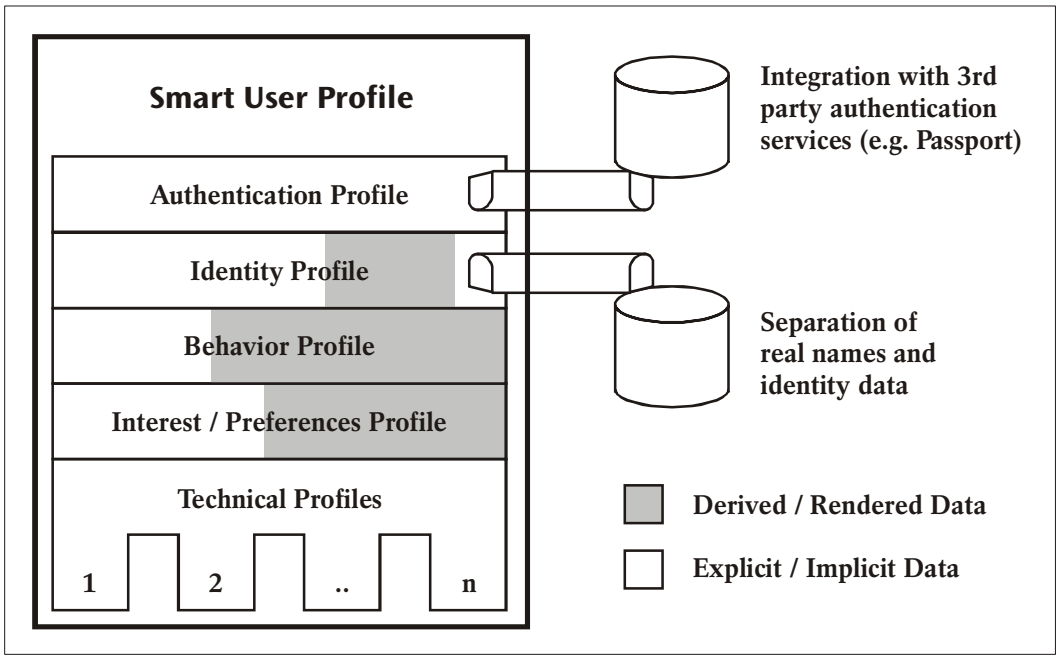


Figure 2: The complementing parts of the Smart User Profile.

3.1 Requirement Specification

A smart learning profile should adapt to the user's requirements over time. That is the profile should be able to follow possible changes in the preferred music style,

[33] Many profiles concepts I have come across during my research for this thesis cover only a small area of the "smart user profile" discussed in this chapter. Unfortunately no widely accepted standard exists, but a large variety of specialized and/or proprietary standards e.g. for modeling learning profiles of students or for end-device profiling are in use. For smart personalization, however, a comprehensive understanding of the user's situation is necessary.

for instance, but also that it should not "overreact" to unique actions such as assuming that the user is a flowers and garden fan only because he has bought flowers on Valentine's day.
Billsus et al. give a good list of requirements for adaptive personalization and adaptive interfaces[34]. I will discuss and extend these requirements throughout this chapter with specific focus on the demands and constraints in wireless application scenarios and also classify them within my model of a Smart User Profile.

"Provide a good initial experience and learn quickly from new users." Probably the most important requirement for well implemented Smart Personalization is to provide an acceptable experience in the first session. A thoughtful general version of the application taking into account some of the most popular choices is the basis for a positive initial use rather than presenting random items to the user. From such a default user profile (or a couple of stereotyped profiles) the system should be able to adapt and learn quickly in order to create benefits such as saved navigation time and a good fit to the user's intention as early as possible.

"Adapt quickly to changing interests." In addition, a smart profile should be able to "react" to changing interests quickly and adequately. These changes can be caused by external events and may be time-, location- or otherwise-limited. Therefore in a smart profile these changes should be reflected in a limited prioritization of certain interests which don't necessarily need to be prioritized in the long run. Examples include users accessing wireless news sites who are not much interested in sports in general but are interested in their national soccer team during the world championship.

"Avoid tunnel vision." Billsus et al. describe this requirement with "Personalization should not get in the way of finding important novel information or breaking news stories."[35] This is actually less a question of the smart profile but of the way how personalization techniques weight the pieces of data adequately.

---

[34] Billsus, D., et al. (2002). Adaptive interfaces for ubiquitous web access. *Communications of the ACM*, 45 (5), pp. 34-38. New York, NY, USA: ACM Press. p. 36

[35] Billsus, D., et al. (2002). Adaptive interfaces for ubiquitous web access. *Communications of the ACM*, 45 (5), pp. 34-38. New York, NY, USA: ACM Press. p. 36

"Use explicit choices and use them wisely." This guideline I would like to add because I believe it is important to verify personalization decisions by asking for explicit input. This way the tunnel vision addressed before can be minimized by an optimized verification cycle. Without these possible verification steps a personalization engine would easily make decisions which are not in the user's intention. This could result in uselessness of the application, dissatisfaction of the user up to the worst case which is the customer terminates using the application.

"Do not require hand-tagging of content with category labels." An advanced adaptive system would also support content creators by automatically adding metatags with category labels to new items. This kind of auto-categorization can also be applied to user input. The search results for the keywords "sf giants" on a news site could, for example, give a list of articles including a shortcut link to the major league baseball news section.

"Avoid brittleness." With Billsus et al. this term means that a "single action, such as selecting something accidentally or skipping over an article on a topic […] should not have a drastic and unrecoverable effect on the presentation". Concerning the requirements for the Smart User Profile this means that temporal and quantitative aspects should be considered for weighting and evaluating each profile's parameter in order to avoid over-weighting.

"Support multiple modes of information access." Although the majority of actions might be performed with one mode of information access (e.g. news access through section headings in case of the Los Angeles Times wireless[36]), Smart Personalization should support different kinds of action triggers. With wireless applications these include for example "related links", keyword search, function and soft buttons as well as quick selection wheels, their content and order of items should be adapted accordingly.

I would like to extend this design guideline with the additional requirement to *"Support multiple channels of application access."* By understanding each access channel's strengths and weaknesses, a smart profile could become richer, fed through different channels such as Web, WAP, SMS and optimizing the applica-

[36] Billsus, D., et al. (2002). Adaptive interfaces for ubiquitous web access. *Communications of the ACM*, 45 (5), pp. 34-38. New York, NY, USA: ACM Press. p. 36.

tion output accordingly. Also the usage behavior towards different channels gives valuable information for the Smart User Profile.

"Respect individuals' privacy." This might be the most critical rule resulting in users accepting or denying adaptive applications. The users should have the possibility to make their choice between the extremes maximum convenience and maximum privacy. Offering explicit opt-in and opt-out might be the best way to increase user acceptance and transparency including the possibility for anonymous usage (i.e. keeping the demographic profile to a minimum) or disabling personalization features (i.e. disabling interest / usage profile) up to deleting the smart profile.

Along with this requirement goes another rule I would like to add: *"Find the appropriate security-convenience ratio"*. It may be wishful thinking to always employ the highest possible level in authentication, transport and storage security. However, from the user's point of view often there is a precedence for convenience over security: "Send me my password" and "Remember login" are only two examples. This thesis argues that the level of security should be adopted to the individual user's smart profile and to the type of action. A mobile online banking application could for example enable users to check their account balance without too much hassle, but for security reasons even a person having activated some auto-login function would be asked for additional authentication and confirmation for money transactions.

3.2 Smart Factors

This is essentially data and implicit user input which a smart wireless application could and should detect and interpret instead of explicitly asking from the user. This data is needed for applying smart techniques for personalization.

3.2.1 User ID

The basis for intra session personalization is a unique identifier per user. During the initial access the application server could send a randomly generated identifier string (a session ID) to the user. By receiving the session ID with every request, the server is able to recognize and track users through an application session.

This scenario, however, would only facilitate adaptation during a single session. When the user accesses the application one day later a new session ID will be issued obviating a learning smart profile but resetting the Smart Personalization process. Therefore a session spanning recognition is needed in order to support returning users. Such a more persistent identification could be achieved with the help of durable identifiers retained by the client or by the access gateway acting as a proxy. With mobile access devices we are in the happy position that an individual device is most likely only used by an individual person which is clearly not the case with many fixed-line internet users who might be accessing an application from internet cafés or universities.
However, this persistent identifier concept has a strong disadvantage: Persistency can only be achieved on the assumption that the initially issued identifier (a cookie, for example) remains intact. In case the cookie expires or the user changes the mobile terminal into a newer model, a new persistent identifier along with a new initial profile would need to be generated, all accumulated data for this user would be virtually lost.

A possible solution is to create a login token (e.g. a username and password combination) for each user which is stored in the authentication profile of the corresponding smart individual profile. Given that, the user receives a persistent access identifier after a successful login procedure. In case the identifier expires for whatever reason, the user can re-access his profile by providing his personal login credentials again. Such an implementation also enables multi-channel access to an application very easily. With the help of valid login credentials a user could access the same application via Web, WAP, SMS or any other channel, each channel having the chance to adapt the service to the same individual.

Web usability guru Jakob Nielsen puts it this way: “The bottom line is that for enabling Smart Personalization techniques the application needs to recognize individuals, not computers”[37]. More details about multi-channel profiling can be found in chapter 5 which discusses a multi-channel prototype I implemented.

[37] Nielsen, J. (2002). *Supporting Multiple-Location Users.* Jakob Nielsen’s Alertbox, May 26, 2002. <http://www.useit.com/alertbox/20020526.html> [Accessed: 6 January 2003]

3.2.2 Location and more

The knowledge of an application about spatial data of the mobile user's location enables useful ways for adapting services to the user's situation. As an important factor within the Smart User Profile, location data has different facets. One can be called "location preferences" where places with particular interest to the user are stored. This includes the user's home city for example, an information which adaptive news services can consider for compiling a personalized list of news items.

Especially interesting in location based services are spatial data about the user's current location which can be gained implicitly by the mobile application. Various localization techniques are in use today, each with its up- and downsides concerning implementation and operating costs, accuracy, usability and time exposure.

Within GSM networks, the mobile terminal can be located based on the ID of the radio cell it is currently using (*Cell Global Identity*). The *Timing Advance* technique enables a more precise location of a user within a cell taking into account a measure of how far away the user is from the aerial mast. An even more precise method is called *Uplink Time of Arrival (UL-TOA)* measuring the received signal from a mobile terminal by using three or more different base stations[38]. While the accuracy of UL-TOA can be relatively precise (~50-100m), CGI and CGI-TA only provide a rough localization of the user, depending on the size of the radio cell, possible interferences with obstacles such as buildings or mountains. Although these real-world conditions are far away from the standard example given by various mobile visionaries about discount coupons being pushed to the mobile handset while walking past a shop entrance, this accuracy still is sufficient for many applications requiring merely town or district-precise location data. As all of these location techniques are network-driven, the MNOs charge the application providers for using these so-called value-added services. These fees unfortunately are still relatively high compared to the value of the information provided. This might be the reason why at the moment we mainly see services provided by the operators themselves using implicitly gained location data.

[38] Discussing deep technical details of different location technologies would go beyond the focus of this thesis. More information is offered by Roth, J. (2002). *Mobile Computing. Grundlagen, Technik, Konzepte*. Heidelberg, Germany: dpunkt.verlag GmbH, pp. 245-280.

Most services therefore use explicit user input such as ZIP code, city or district name, highway numbers down to room numbers with local in-door systems. Although this burdens the user, smart personalized applications can try to minimize additional explicit input costs by pre-selecting upcoming choices accordingly.

Another way for gaining location data without being charged per information are satellite-based systems which include the Global Positioning System (GPS) and the upcoming European Satellite Navigation System GALILEO[39]. In contrast to the network-based location techniques mentioned before these systems usually can only be used in outdoor environments[40] and require an additional receiver at the mobile device resulting in increased initial costs for the user.

Other localization methods include point-based triggering[41] and relative positioning, i.e. detecting the proximity of a user's device based on its presence in a short-range personal area network (e.g. Bluetooth). This offers new interesting personalization possibilities as I describe further in chapter 4.4.2. Table 1 gives an overview of the relevant localization techniques discussed in this chapter.

For gaining a more comprehensive view on the user's location, Brücher suggest to use an extended location model[42], which adds 5 more entities to the current *geographical position data*, which can be of particular use to smart personalization techniques. Knowledge about the user's *range of action* enables applications to recommend only actions which are within the reach of the user within a specific

[39] GALILEO is to be commercially launched in 2008. It is supposed to be interoperational at user level and compatible at system level with GPS. Up-to-date information can be found at <http://europa.eu.int/comm/dgs/energy_transport/galileo/index_en.htm> [Accessed: February 2003]

[40] In-door navigation could be enabled though by positioning so-called "pseudolites" within the particular building as proposed by von Schoultz, F. / Space Systems Finland (2001). *Indoor Satellite Navigation.* Presentation during the Mobile Navigation session, Interactive Future & Man Conference, Mindtrek 2001, 8 November 2001, Tampere Hall, Tampere, Finland.

[41] Butz proposes a PDA-based museum guide which is triggered by signals sent by infrared beacons in Butz, A. (2002) *Taming the urge to click. Adapting the User Interface of a mobile museum guide.* In: ABIS-Workshop 2002: Personalization for the mobile World, Proceedings, pp. 9-12. <http://www.kbs.uni-hannover.de/~henze/lla02/proceedings/ abis.pdf> [Accessed: 5 January 2003]

[42] The following factors were introduced by Brücher, H. (2002). *Lokalisierung als Aspekt der Personalisierung mobiler Kommunikationsdienste*. In: ABIS-Workshop 2002: Personalization for the mobile World, Proceedings, pp. 51-58. <http://www.kbs.uni-hannover.de/~henze/lla02/ proceedings/abis.pdf> [Accessed: 5 January 2003]

time frame. An algorithm could estimate this geographical area based on knowledge about the user's *direction of movement* and his *movement speed*, which both can be derived from time-shifted measurements of the geographical position. The velocity also influences two more parameters which Brücher describes as the *situation of actions* and *time reference*. The situation of actions covers the basic conditions of the user's perception based on location criteria and secondary sources (e.g. With a high movement speed and activated radar detection services an application could automatically switch to voice mode). The time reference in fact is based on the movement speed and on second sources as well, time and timeframes, and enables to estimate values such as the time-based changed of the user's position (e.g. for traffic jam warnings) or drawing connections between location and opening hours of stores. With many mobile applications it can make sense to see these two dimensions together.

Method	based on	accuracy	costs
CGI	network	cell size	value-added service charges
CGI-TA	network	~ 100-200m / ~ 550m[43]	value-added service charges
UL-TOA	network	~ 50-150m	synchronized base stations, value-added service charges
Satellite	terminal	~ 10m (outdoor)	initial costs for GPS-enabled terminal, computing costs.
Explicit input	user	up to door-to-door precision.	additional explicit user input
Point-based triggering	terminal + beacon	~ 5m	initial beacon costs. With infrared: active pointing to the beacon.
Relative	personal area network	~10-100m	PAN-enabled handset, other users / fixed senders needed

Table 1: Overview of different localization methods.

[43] Accuracy depends on MNO implementation, TA can measure the distance of a user's terminal to the base station in ~550m steps. In the three-sector configuration, more precise results can be achieved by reducing the possible angle to 1/3. For more details on this issue see Andersson, C. (2001). *GPRS and 3G Wireless Applications: professional developer's guide.* New York, NY, USA: John Wiley & Sons, Inc. pp. 260-262.

3.2.3 Time and more

The time factor is a very interesting one for Smart Personalization. Possible time data includes time of day, day of the week, date and seasonal or holiday information, event time data, birthdays, user date book appointments as well as derived and secondary time data such as opening hours or the waiting time at a border checkpoints[44].

In combination with the location data, time can be a factor for actions or events being possible only within a specific time frame, as described in the previous chapter. Let us take an intelligent mobile calendar application as an example: The user has entered a meeting at an off-site location 50km from the company headquarters away. Because he usually goes by car the calendar is monitoring the road and traffic situation on the possible routes. Two hours before the meeting the application notifies the user that he should expect road constructions on his route resulting in an approximate delay of 15 minutes.
Seasonal and holiday information are also significant for Smart Personalization. If a mobile user orders artificial spiders in our smart personalized we-got-everything m-shop three days before Halloween, he doesn't automatically need to be a spider fan during the next months as well. Working time versus leisure time is another differentiation a Smart Personalization engine should be able to take into account. To differentiate between client and server time might be only necessary with specific applications being used in different time zones.

A combination of time and location data can also be employed to create new mobile marketing offers, i.e. location and time dependent marketing messages. Let's imagine the following scenario: It's 8p.m. and the user is approximately 1km away from his favorite club. He has subscribed to the VIP Happy Hour Mobile Service. It might be an interesting idea to send at this time and context a message such as the following:

```
XYZ club VIP offer: Free entrance and one free Caipirinha drink if
you make it till 9p.m. to us – discount code AD231
```

Code 1: Example of a personalized discount coupon sent to a user's mobile phone.

[44] At the EUROPRIX 2001 competition, the WAP site of the Polish customs service was awarded in the category "mobile multimedia" with their useful service to check the waiting times. via mobile phones. The WAP service is available at <http://wap.guc.gov.pl> [Accessed: 20 February 2003]

Because of the knowledge about past visits the intelligent messaging server is able to create a drink offer based on the user's drink orders and check-in times in the past with an expiration time based on the user's current context (1km away, well reachable within 1 hour).

3.2.4 Device and Network Factors

Interesting not only from the presentation point of view are profile data about the mobile terminal devices. As part of the technical profile, device data such as device type, screen size, input facilities, color enabled are valuable pieces of information for adapting the presentation layer to the individual devices capabilities and constraints. Besides a base presentation type differentiation in browser-based applications (also see chapter 5.4), more sophisticated implicit personalization is possible such as text-wrapping and content volume adaptation according to the terminal device's screen size, dynamic graphics generation with size and quality depending on the terminal specs and network speed as well as the usage of specific functionalities supported by the handset or browser such as manufacturer-proprietary APIs, support for special input keys and version specific language features. While WAP 1.2 enabled phones are able to associate a shortcut access key with text anchors (i.e. simply pressing the 1, 2 or 3 softkey activates the corresponding hyperlink), older WAP 1.1 enabled browsers will show an error message when displaying a WML 1.2 document.

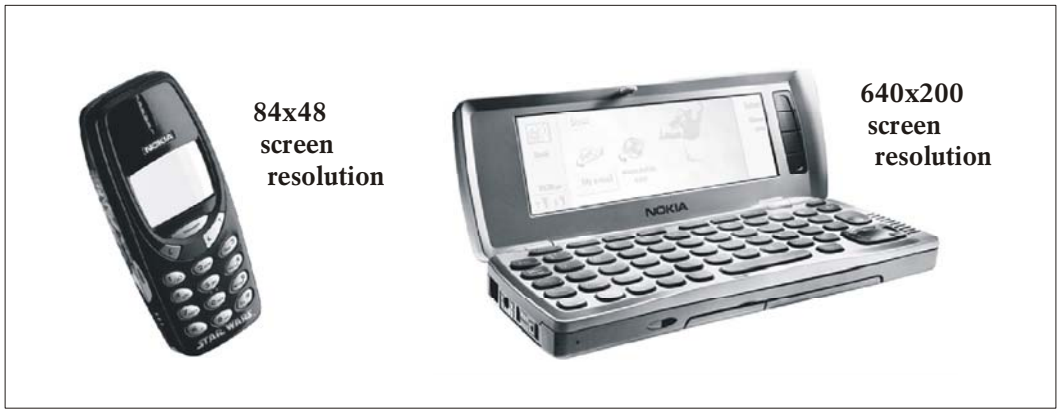


Figure 3: Nokia 3330 vs. Nokia 9210i – One size does not fit all!

For profiling browser and device characteristics in particular, different approaches exist. In the following I will introduce and discuss 2 solutions with WAP and i-mode enabled mobile phones.

The starting point for identifying and profiling is the client request received by the application server. This request is usually performed by a proxy, a MNO gateway server acting as middleman between mobile terminal and server. The communication between the gateway and the application server is based on public internet standards, namely HTTP and TCP/IP. Of particular interest from the mobile application provider's point of view are the HTTP header data the application server receives. In order to get an overview of which header information a MNO reveals to content providers I have written a small TCP test server to monitor incoming data:

```
1   #!/usr/local/bin/perl -w
2
3   # TCP testserver for sniffing MNO gateway header data
4   #
5   # For testing with mobile phones I recommend creating a no-
ip.com
6   # entry for your computer unless you don't have a static IP.
7   #
8   # Please feel free to use and modify as you like.
9   # Cheers,
10  #  Matthias Hellmund <hellmund@mitbiz.de>
11
12  use IO::Socket;
13
14  use constant MYPORT => 80;
15  $sock = new IO::Socket::INET(LocalPort => MYPORT,
16                  Reuse     => 1,
17                  Listen    => 5)
18      or die "can't create local socket: $@\n";
19
20  print ">TCP testserver< for sniffing WAP gateway header
data\n\n";
21  print "Please point your mobile's browser to this computer's
URL.\n";
22  print "All incoming header data will be printed to
stdout...\n\n";
23
24  print "Accepting TCP connections on Port ", MYPORT, "...\n";
25  while ($client = $sock->accept()) {
26      print "Accepted connection from ",
27            $client->peerhost(), ":", $client->peerport(), "\n";
28      while (<$client>) {
29      chomp;
30      print $_, "\n";
31      }
32  }
```

Code 2: testserver.pl – a TCP test server implemented in Perl.

During my tests I have been using different mobile phones and gateways of all four MNOs in Germany (T-Mobile WAP, Vodafone D2 WAP, E-Plus WAP and i-mode, O2 Germany WAP). For device type identification the HTTP header "User-Agent" can be used which is generated by the mobile terminal and passed on the server by all gateways tested. However, identifiers such as "portalmmm/1.0 n21i-10(c10)", "Nokia9210/1.0 Symbian-Crystal/6.0" or "SonyEricssonT68/R201A UP.Link/5.1.1.5a" still need to be translated into device measures for use by the application.

One possible solution is to maintain an own library of device user agents and their specifications. Wallace et al. suggest an implementation for different i-mode handsets[45] while others actively maintain closed databases of device parameters. These approaches clearly have the disadvantage, that only "known" devices can be identified and the parameters selected accordingly. In case of a terminal model accessing the application, which is not yet listed in the associated device database, the presentation adaptation can only make use of a general "unknown device" profile. Because of that, this model requires continuous maintenance costs for keeping the device base up to date.

Accumulated Profiling

A promising approach is suggested by the Open Mobile Alliance, formerly known as the WAP Forum, the body defining the WAP protocol suite standards. The *User Agent Profile (UAProf)* specification[46] describes profile classes containing information used for content formatting purposes. During my brief testing line-up the SonyEricsson T68 mobile phone was the only one out of 6 devices which at supported the UAProf specification.

---

[45] Wallace, P., et al. (2002). *i-Mode Developer's Guide.* Boston, MA, USA: Addison-Wessley. pp. 522 ff.

[46] Open Mobile Alliance, Ltd. (2002). *User Agent Profile 1.1. Candidate Version 12-December-2002.* OMA-WAP-UAProf-v1_1-20021212-c. <http://www.openmobilealliance.org/docs/ OMA-UAProf-v1_1-20021212-C.zip> [Accessed: 20 February 2003]

```
1   Accepted connection from 139.7.29.1:10191
2   GET /tcp_serv.Hellmund.thesis HTTP/1.1
3   x-up-uplink: lh-base.vodafone.de
4   x-up-fax-limit: 100000
5   Profile: http://wap.sonyericssonmobile.com/UAprof/T68R201.xml
6   x-up-subno: 979217653-60002223_lh-base.vodafone.de
7   x-up-fax-accepts: text/plain, application/postscript, applica-
tion/msword, application/rtf, application/pdf
8   host: wap.mitbiz.no-ip.com:80
9   Accept-Language: de
10  User-Agent: SonyEricssonT68/R201A UP.Link/5.1.1.5a
11  x-up-devcap-max-pdu: 3000
12  Accept-Application: 1
13  Accept-Application: 2
14  x-up-devcap-charset: us-ascii, iso-8859-1, utf-8, iso-10646-
ucs-2
15  X-Forwarded-For: 10.218.255.237
16  x-up-WTLS-info: off
17  Connection: close
18  Encoding-Version: 1.3
29  x-up-wappush-secure: www.openwave.com:9003/pap
20  x-up-fax-encodings: 7bit, 8bit, base64, quoted-printable
21  Accept: application/vnd.wap.wmlc, application/vnd.wap.wbxml,
application/vnd.wap.wmlscriptc, application/xhtml+xml, applica-
tion/vnd.wap.xhtml+xml, application/vnd.wap.mms-message, */*,
text/x-wap.wml,text/vnd.wap.wml,text/x-
hdml,text/html,text/vnd.wap.wmlscript, */*
22  x-up-wappush-unsecure: www.openwave.com:9002/pap
23  Bearer-Indication: 0
24  Accept-Charset: us-ascii, iso-8859-1, utf-8, iso-10646-ucs-2,
UTF-8, *
```

Code 3: HTTP request header sent by T68i mobile phone through Vodafone WAP gateway

In this example line 5 of the HTTP request headers provides the mobile application developer with a URL to access comprehensive device specifications. The underlying RDF document contains valuable information about screen size, color capabilities, WAP characteristics such as browser version and installed WMLScript libraries, network characteristics and messaging facilities. However, the main problem preventing frequent implementation of UAProf detection and adaptation seems to be that only very few devices include the appropriate UAProf header in their server request, a positive example is the SonyEricsson T68i transmitting the UAProf "Profile" header properly according to the OMA UAProf specifications[47]. This thesis proposes that the MNOs' WAP gateways should automatically add a suitable "Profile" header to requests from devices not

[47] Open Mobile Alliance, Ltd. (2002). *User Agent Profile 1.1. Candidate Version 12-December-2002.* OMA-WAP-UAProf-v1_1-20021212-c. <http://www.openmobilealliance.org/docs/OMA-UAProf-v1_1-20021212-C.zip> [Accessed: 20 February 2003] p. 16.

supporting UAProf yet. Because a mapping from HTTP user-agent identifiers to the corresponding UAProf RDF documents, which have been created for legacy handsets as well, is technically possible it is desirable to not let every mobile application provider do these mappings and maintain the underlying database but rather have this kind of "UAProf header generator" located at gatekeepers such as the MNO gateways or offered as web services[48]. This way the resulting technical profile can easily be built from terminal, gateway and external UAProf data.

The reality today unfortunately looks a little different. Instead of acting as gatekeepers supporting mobile application providers as well as possible (e.g. by providing anonymous user IDs and device identifiers such as UAProf), many MNOs are offering these basic value-added services exclusively to their "walled garden" content partners and not to so-called "unofficial content providers". In the beginnings of the fixed-line online boom AOL, CompuServe and others tried to keep their customers as much in their sphere as possible but had to step back to the gatekeeper function with charging for traffic as the main revenue stream because of the success and wide support of open standards such as TCP/IP, HTTP, HTML. The MNOs might be in the latter position soon, however still quite successfully keeping the technical data about their clients for themselves.

External Profiling

"Vodafone live" for example is a walled garden online service with a revenue sharing model between content providers and Vodafone. With "Vodafone live" the content partners don't get to know much about the user's handset because they usually deliver not content and services tailored to the user's device, instead they are to send a proprietary "PartnerML" document to the Vodafone servers, a confidential XML standard defined for the Vodafone live program. This way the device adaptation and formatting is done at the MNO, giving the content provider less control over the output and even handling page breaks.

[48] The current OMA UAProf 1.1 Candidate version formulates this desirable step only not binding on page 52: "For those devices that do not directly support […] UAProf information, indirect support may be provided by the gateway."

On-device Presentation Adaptation

Another upcoming development seems to be that more adaptation of the presentation layer is shifted to the mobile handsets. Browsers such as Microsoft Internet Explorer for Pocket PC or Opera for Symbian OS featuring “small screen rendering” support are trying to display standard web sites in a reasonably usable way on small screens. Difficulties during this process of auto-adaptation are inevitable: Even though images are being downsized on-the-fly and formatting elements left out or modified (e.g. frames), the full data volume like on a regular web browser needs to be transmitted to the mobile terminal device resulting in unnecessary traffic fees. Smart personalization goes a critical step further here and requires a mobile application to be tailored as a whole to individual device and network constraints. This includes intelligent and optimized network transport, caching and synchronization with at least parts of the adaptation process taking place server-side. More details about device and network adaptation techniques as well as a working prototype are discussed in chapters 4 and 5.

3.2.5 HCI Data and History

Knowledge about the Human Computer Interaction (HCI) data, i.e. the user behavior during the current and past sessions, are of particular interest for adaptive application developers. From a mobile user’s “navigation path”, intelligent algorithms can try to predict the next steps and support the user in various ways in achieving his goals. Also knowledge about previous application sessions is valuable information helping adaptive techniques to categorize, understand and support a user unobtrusively by building up a learning profile. Eventually this kind of implicit personalization can reduce time-consuming explicit input efforts.

The level of detail in which a mobile application can record a user’s navigation path primarily depends on client side implementation and the technologies, and device hardware being used. Chapter 4 discusses constraints and opportunities of different technology layers in more detail. However, the primary rule of thumb should be to keep the user in control of which data is recorded and used and which is not. Technically possible is a lot: Measuring the time between two “clicks”, monitoring function keypads and scrolling behavior on richer client in-

terfaces[49], recording the surrounding sound and taking pictures with the built-in digital camera. However, a total observation of mobile application users isn't possible yet, fortunately, due to privacy regulations, technical limitations such as storage and network constraints and most importantly because of the user himself, who will carefully measure the level of intrusion versus its return in terms of smarter mobile applications.

"Behavior Profile" is the part of the Smart Profile that contains HCI data of active and past sessions. In contrast to web log mining[50], which usually ex post analyzes server access protocols, real-time techniques can draw conclusions from the "Behavior Profile" supporting momentary user actions.

3.2.6 Secondary Sources

Taking adaptivity to the next level, Smart Personalization can also utilize secondary data sources, i.e. data outside of the single user-application-sandbox[51]. This includes resources on the user's mobile device such as calendar entries, the user's telephone book or his emails, for instance. Also many data sources outside of the user's sphere could be utilized such as weather or traffic report services. Last but not least connecting the current mobile user's profile to other users of the application, for example peer users in the vicinity according to profile factors, can give a great source of knowledge about relationships, similarities and differences. The final step would be mobile profiles swarming between clients, servers and their applications.

---

[49] *Richer client interfaces* here means applications on the end-device which have access to a richer level of (information) resources (e.g. native C++ applications or Java Midlets, more details follow in chapters 4.1 to 4.3) in contrast to simple microbrowser-based applications. Most "richer" clients on mobile end-devices are still relatively restricted in size compared to desktop PC applications.

[50] A good overview on web log mining can be found in Anderson, C.R. (2002). *A Machine Learning Approach to Web Personalization.* Ph.D. thesis. University of Washington, Department of Computer Science and Engineering. <http://www.the4cs.com/~corin/research/pubs/thesis.pdf> [Accessed: 13 February 2003] pp. 144 ff.

[51] The term "sandbox" is commonly used to describe the restricted access rights of Java applets in the fixed-line internet world. A similar concepts is used with J2ME (Java 2 Micro Edition) applications, which I discuss in more detail in chapter 4.2.

In practice, the mobile application provider has to decide which implicit and explicit data are best suited for the Smart Personalization techniques utilized. He finally needs to assess utility versus implementation and operational costs such as subscription fees for external value-added services.

3.3 Explicit Factors

In the previous chapter I have discussed some implicit data which an adaptive application can consider for making decisions about formatting, about the actions and content being presented and about which items are delivered proactively to the mobile user. For what we call "Smart Personalization", also explicit factors should be taken into account.

3.3.1 User's Preferences

Many applications, be it desktop or web applications, give the users the possibility to customize "their" application. This explicit personalization is often named "Options", "Setup" or "Preferences". The advantage of this approach is that it gives the user direct control over several options, we also can consider the information provided by the user "assured" information reflecting the user's explicit preferences for design or display of certain content, for instance. The disadvantage is that the user has to take the initiative and go through lists of several options to express his preferences. What gives difficulties to desktop users already becomes a burden for small-screen mobile users when exaggerated. While presenting a list of checkboxes to PDA users is still feasible, offering the same list menu on smaller mobile phones isn't appropriate anymore. Therefore some mobile services offer user to maintain their preference settings on a regular web site. I-mode customers of E-Plus in Germany can customize their home menu and premium service subscriptions via the E-Plus website[52], for instance. But as I mentioned earlier in 3.1., these preferences shouldn't result in a "tunnel vision"; positively said: the Smart Personalization engine should take the explicit preferences as guidelines for tailoring the service to the user's best interests and not as a hard restriction. In contrast to many implementations being in use today, I believe that

[52] Customers of E-Plus i-mode can customize their home menu at <http://www.eplus-imode.de/> [Accessed: 19 February 2003]

explicit changes to the preferences should be possible on the mobile interfaces as well and not solely on the web. Rather than introducing an overloaded all-including "Preferences" section in the main menu, mobile application developers should give direct access to channel specific options only. For users of a mobile sport fan portal it should be possible to manage the subscription of their MMS newsletter, for instance, whereas changing the e-mail newsletter subscription settings is part of the preference settings which are fine for being managed on the web only. Especially suited for mobile devices with limited screen real estate is to verify and modify if necessary single preference settings by proactively asking single questions depending on the person's usage behavior. A thoughtful number of proactive questions seems to be useful because reports show, that usually only 2%-5% of the mobile users customize their interfaces. In case of the Los Angeles Times wireless edition, for example, fewer than 3% of the users had explicitly set their preferences[53] underlining the need for adaptive, Smart Personalization.

The following example is a use case for preferences combined with adaptive behavior: After registering at "smartmobilemusic.com", "Britney Broadband", our sample user, chooses her current favorite bands from a selection list in her desktop web browser. If these bands release some new CDs or hit the headlines the information will be sent to her mobile phone immediately, which is still "only" to customize the content. However, based on Britney's preferences a smart mobile application could go a step further and adaptively personalize the data presented to the user. In the underlying band database one or multiple genres, which are stored in a hierarchical genre tree, are assigned to each band. This makes it possible to not only publish a record release of a particular band to the user who explicitly tagged this band's name in their preferences but also to those interested in similar bands. The application could reason, for example, that Britney might also like the band "The Falling Stones". It so happens that the "Falling Stones" give a concert in the town where Britney is sojourning at the moment. The location based smartmobilemusic.com service could therefore send a special discount coupon to Britney's mobile phone.

[53] Billsus, D., et al. (2002). Adaptive interfaces for ubiquitous web access. *Communications of the ACM*, 45 (5), pp. 34-38. New York, NY, USA: ACM Press. p. 36.

3.3.2 Identity Factors

The nature of identity data such as birthday, full name, postal address etc. is slightly different from user's preferences. Although usually entered explicitly by the user as well, any data in the "identity profile" is part of the most personal information an application can ask for. Therefore this data should be collected, handled and stored with special care. The maxim "the more the better" is only partly true in this context: Of course the more details on the personal data is made available to the personalization logic, the more specific rules and filters can be applied. Similarly to the user's preferences, identity data can be collected carefully over time, also during multiple sessions. A useful rule of thumb for collecting needed identity data is to make the user's benefits clear for revealing personal bits of information. Stolze and Ströbele[54] propose a framework for adaptive interviewing minimizing the exit risk which can also be applied to critical profile building elements like the identity factors. In any case, a first step should be to thoroughly question the necessity of each data field for mobile users and reduce the number of fields (i.e. also reducing the number of questions) to the context related minimum. During the BAHNMIX prototyping process, which I will discuss more detailed in chapter 5, the number of required fields in the mobile versions has been reduced significantly, for example.
Identity factors can be used in a variety of cases. An interesting application surely is mobile marketing where identity data like age, home city, gender and the user's real name can be employed for generating personalized targeted marketing messages such as:

```
"Hello Mike! Bank XY in Z street offers you an upgrade to the junior savings account super+. Sign up this week to receive a free computer game!"
```

Code 4: Short message example for personalized mobile marketing.

Gender and age specific content and services play a role in many personalization efforts, be it the visual appearance such as default color themes or the emphasis on more gender-specific services (e.g. offering daily horoscope subscription ser-

[54] Stolze, M., Ströbel, M. (2001). Utility-based Decision Tree Optimization: A Framework for Adaptive Interviewing. *User Modelling 2001*, edited by M. Bauer et al., LNAI Vol. 2109, Berlin, Germany: Springer. pp. 105-116.

vices primarily to female users). For some services such as mobile dating applications for instance identity factors are actual search criteria.

3.3.3 Explicit Verification

Eventually all decisions derived from the Smart User Profile are based on assumptions and probabilities. Is the user satisfied with the output adapted to his probable needs? Even if the user has set up his profile explicitly two month ago, can a mobile application provider be sure that all options selected are still valid today? Only the user is able to answer these questions precisely. Understandably, an adaptive application doesn't need explicit user confirmation on every single action. The implicit HCI data input combined with machine learning techniques can already give a good probability as described in 3.2.5, but not more.

This thesis argues that with critical decisions affecting important profile and/or transaction data the user should be given the opportunity for explicit verification where possible. The explicit input method depends on the type of profile data to be verified. Possible methods include

- unary action expressions (e.g. "[Ignore this user]")
- binary decisions (e.g. "Is this billing data correct? [Yes] or [Edit]")
- scalar decisions (e.g. "Please rate the suggested product on a scale between 0 (poor) to 9 (great):") and
- selection decisions (e.g. "Which track of the following do you like best?").

As demonstrated in the examples, the question should only cover one topic, combined questions such as "Was this article interesting and did you like it?" should be avoided. Explicit verification can occur in an alerting disruptive way or also placed optional unobtrusively as shown in figure 4.

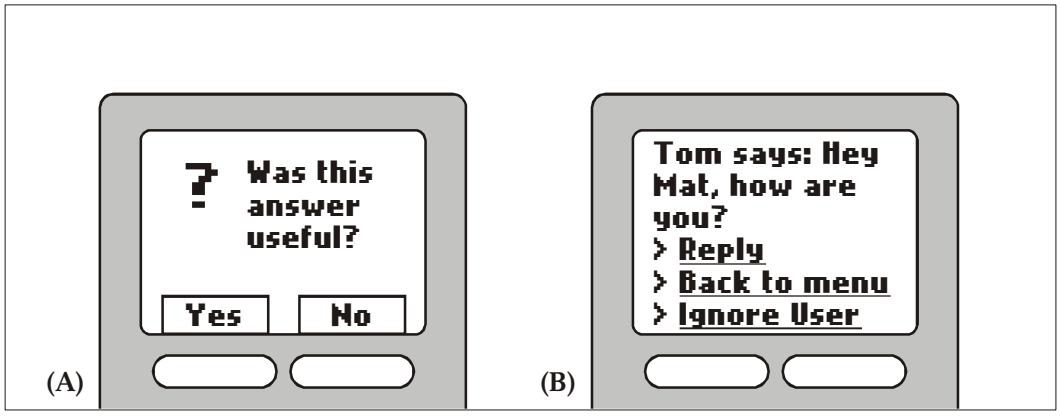


Figure 4: Explicit verification with (A) alert choice and (B) optional "ignore" action.

3.4 Smart Personalization Techniques

Smart Personalization tries to utilize and process both, explicit and implicit factors, to achieve a better individual user experience. In this chapter I present and discuss different techniques covering their area of application and one or more successful implementation examples each. The selected personalization techniques can all be applied in real-time applications, i.e. for immediate benefit to the user. However, in some cases a non-real-time deployment is also feasible, for example in the area of mobile push marketing. Highly personalized services usually combine two or more of the techniques introduced in the following.

3.4.1 Rule-Based Personalization

In a rule-based personalization engine, rules being relevant to the business model are described and processed. Usually these rules are of static nature, i.e. they can't follow dynamics automatically, however they can be changed explicitly on-the-fly by a business manager, for example. For this purpose an easy-to-learn pseudo-code similarly to simple programming languages can be used to create and modify rules in some rule-based engines.
The following example shows rules that could be used in mobile applications:

```
IF (new_user) THEN show_introduction
IF (content = news) AND NOT (hasread_topnews) THEN add_topnewslink
IF (numberofvisits = 5) THEN offer_tellafriend
IF (is_mms_capable) AND NOT (is_mms_subscriber) THEN offer_mms
IF (is_premium_user) THEN show_exclusive_story
                     ELSE show_exclusive_teaser
```

Code 5: Pseudo code for rule-based personalization of a fictive mobile news site.

Rule-based personalization is useful for granting the application provider direct control over the personalization logic. Fixed rules can be captured quite easily in static rule-based personalization logic. Rule-based systems however are not capable of learning using dynamic data sources to discover trends over time. It is the application provider's task to constantly analyze rule-based systems and manually optimize and feed new rules into the system resulting in increasing complexity with a high number of rules and ultimately costly manpower investments throughout the life of the solution. Therefore within dynamic mobile applications rule-based personalization should be combined with other techniques.

3.4.2 Content-Based Filtering

The Content-Based Filtering technique tries to filter items based on semantic similarities, i.e. according to correspondences of one or more item parameters, to generate relevant recommendations. This way, after renting the DVD "Terminator 2", a mobile video reservation service could recommend the movies "Terminator 1", "True Lies" and probably "Collateral Damage" having the same leading actor or even the same director.

The advantages of Content-Based Filtering include that this method closely pays attention to the individual user's profile which is especially useful if the user does not fit into any simple grouping. The fact that also new items can be recommended to the user without defining new explicit rules is of particular interest to applications with large amounts of content items, e.g. a ring tone download site. Among the difficulties and limitations of Content-Based Filtering are the following: By definition, Content-Based Filtering can only suggest similar items in the same domain, i.e. James Cameron and Arnold Schwarzenegger DVDs in the previous example. With a limited range of choices recorded, this can quickly turn into an over-specialization resulting in a very narrow view (see "avoid tunnel vision" in chapter 3.1).

3.4.3 Collaborative Filtering

Like the name indicates, collaborative filtering engines are able to create recommendations based on explicit and implicit "collaboration" of multiple application users. The basis for this personalization is the assumption that persons with similar tastes will also have similar interests and therefore react similarly in comparable usage situation. In practice that means that one user's smart profile is compared with the interest/preferences profiles of other users. Based on similarity matches, i.e. being grouped with others who seem by their purchases to share the user's interests, recommendations can be delivered accordingly. Collaborative filtering techniques are probably known best from the web shop Amazon.com. For Amazon's web pages product recommendations are created based on similar purchases of other users ("Customers who bought this book also bought…"). In the area of mobile applications, PTVplus[55] is a personalized TV guide which em-

[55] PTVplus can be accessed with a web or WAP browser at <http://www.ptvplus.com/> [Accessed: 19 February 2003]

ploys, like Amazon, collaborative and content-based filtering techniques in a hybrid system with explicit rating[56]. Collaborative filtering in its clear form is solely based on explicit choices (e.g. purchases) of other users. While, in contrast to content-based filtering, it is able to suggest items which are of a different domain (e.g. recommending an action movie to the watchers of an American football game), it can hardly recommend new, unpopular or very specific items due to the lack of collaborative data for these items. Also, for good results a critical amount of explicit input needs to be available to the collaborative filtering engine. In practice Collaborative Filtering and Content-Based Filtering are often combined due to their complementary qualities and weaknesses.

3.4.4 Behavior-Based Analysis

By analyzing available HCI data from active and past sessions, the behavior-based Analysis can derive possible interests. This analysis should be performed in real-time, compared with findings from other (peer) users in order to generate useful recommendations.

One example for generating such recommendations (here: short-cuts) is the MINPATH algorithm discussed by Anderson[57] which uses a trail model of the user's navigation path through the site or application. Based on the recorded "trail prefix" (i.e. the accumulated HCI steps), MINPATH is able to generate shortcut links based on the probabilities and expected utilities for the individual taking the corresponding "trail postfix".

Other solutions such as ChangingWorld's ClixSmart Navigator[58] try to reduce the "click-distance" (the number of clicks required to reach the desired content) by dynamically adapting the orders of menu items to the user's behavior and preferences. The WAP portals of O2 and Vodafone have implemented ClixSmart navigator already. O2 Germany reported that they were able to reduce the average click-distance by 30%.

---

[56] Cotter, P., Smyth, B. (2000): WAPing the Web: Content Personalisation for WAP-Enabled Devices. *Proceedings of the International Conference on Adaptive Hypermedia and Adaptive Web-based Systems,* (AH2000), Trento, Italy. LNCS 1892, Springer. pp. 98-108.

[57] Anderson, C.R. (2002). *A Machine Learning Approach to Web Personalization.* Ph.D. thesis. University of Washington, Department of Computer Science and Engineering. <http://www.the4cs.com/~corin/research/pubs/thesis.pdf> [Accessed: 13 February 2003] pp. 46-65.

[58] More information about ClixSmart can be found at <http://www.changingworlds.com/>.

In contrast to Collaborative Filtering the Behavior-Based Analysis is primarily based on implicit data, i.e. HCI information. Although anonymous usage is possible with Behavior-Based Analysis, for best results it requires a session-spanning recognition of an individual user as well as constant recording, analysis and usage of all movements within the application. Because this may rise security concerns with some users, O2 Germany, for instance, has integrated an opt-in and opt-out mechanism into their WAP portal.

3.4.5 Stereotypes

Stereotyping is a helpful technique in determining the user's general preferences regarding an area of interest. Chin and Porage[59] describe their usage within a framework for interactive product or service customization. The idea behind implementing stereotypes in a personalized application is that we can create a limited number of stereotype profiles beforehand, each with a different set of attribute importance weights. Based on the actions of an individual user, the personalization engine is able to determine the likelihood of a the user belonging to a particular stereotype.

To give an example: For a mobile restaurant search engine an application provider could define stereotypes such as "fast-food junky", "fish fan", "food-insight searcher", "executive vegetarian" and more. New users logging into the system for the first time start out as members of the "average person" stereotype. Chin and Porage propose that, going from there, additional memberships should be determined by asking the user the "most useful question" in order to reduce the levels of uncertainty regarding the membership of particular stereotypes until the usefulness of the best query is below the threshold of user impatience[60]. At the end of the querying process, a recommendation can be made based on the calculated attributes (i.e. the user is interested in low-priced non-vegetarian food within 500m radius).

Implementing stereotypes is a useful personalization technique which can offer appropriate results with a relatively small number of queries. With mobile applications, implicit factors such as location and time should be taken into account as

---

[59] Chin, D. N., Porage, A. (2001). Acquiring User Preferences for Product Customization. *User Modeling 2001*, edited by M. Bauer et al., LNAI Vol. 2109, Berlin, Germany: Springer. pp. 95-104.

[60] See Chin, D. N., Porage, A. (2001). Acquiring User Preferences for Product Customization. *User Modeling 2001*, edited by M. Bauer et al., LNAI Vol. 2109, Berlin, Germany: Springer. p. 99-101.

well to minimize user input times. Parts of the saved time should then be taken for user feedback on the presented results.

3.4.6 Smart Input

Especially on devices without full keyboards, smart input technologies can substantially improve the user experience. The T9 text input implemented in many mobile phones today is a good step towards this goal. Another system, "eZiText" by ZI Corporation[61], enables its one-touch predictive text input across different applications in multiple languages (e.g. German and English) featuring automatic learning and tracking of usage patterns.

Another technique especially useful with search functionalities is fuzzy logic. Properly implemented, an application is able to return the intended results even if the search query contains typos. Combined with Content-Based Filtering (see chapter 3.4.2) an application can add a selection of similar items for providing better results on minimum input.

Further possibilities to improve the most critical part of mobile applications, the input interface, include pre-selecting the most probable options, pre-filling form fields or providing a list of most likely values to choose from in order to minimize explicit user input costs.

3.4.7 Versioning and Dynamic Layout

The very different and limited screen real estate on mobile devices requires the application provider to optimize the presentation output according to the individually available resources. When we take a look at the current portfolio of Nokia WAP phone displays, the screen sizes vary between 84x48 and 640x200 pixels[62]. Layout adaptation engines try to solve this problem by automatically rendering specific outputs to individual devices based on available device factors.

Simple solutions within this area of personalization include flexible layouts, which are based on relative positions. This way buttons, for instance, would be assigned

---

[61] Details on eZiText can be found at <http://www.zicorp.com/ezitext.htm> [Accessed: 20 February 2003]

[62] Based on Nokia (2002). *Nokia WAP Phone Characteristics, Version 1.8, 18 Nov 02.* <http://nds1.forum.nokia.com/nds/NDS_TVerification_Interface?path=%2Fdownload%2FNokia%5FWAP%5FPhone%5FCharacteristics%5Fv1%5F8%2Epdf> [Accessed: 3 January 2003]

positions such as "on top of the text container" rather than being positioned with absolute values and fixed width and height parameters. Ideally the mobile application provider combines these "fluid layouts" with content adaptation rules limiting the number of navigation items per page depending on the screen size, for instance. Further examples of adaptive layouts include dynamic image rendering and scalable layouts facilitated by vector graphic standards such as Macromedia Flash or SVG mobile profile[63].

Another approach to adapt an application to individual device constraints is called versioning. By deploying different versions for each set of end-devices the mobile application provider can optimally utilize not only the available screen real estate but also device- or platform-specific functionalities and APIs[64]. This approach is advisable with enterprise applications that need to be optimized for a limited variety of devices only as well as for mobile game developers who want to take each device version to the cutting edge including individual graphics, light, vibrating and sound.

3.4.8 Adapting to Wireless Networks

Unlike in the fixed-line internet world where people are used to relatively reliant, fast and cheap network connections, mobile application developers need to thoroughly implement ways for dealing with the difficulties of wireless networks. From the technical viewpoint the following network issues need to be solved: handling interruptions (e.g. in areas without network coverage), dealing with latency (i.e. the network delay before getting a response to a request), minimizing the effects of packet loss while maximizing transmission efficiency as well as including compression, caching and buffer mechanisms. Simulators exist such as the Ericsson GATE[65] allowing the mobile application developers to optimize "their" wireless transmission figures.

From the user's point of view, however, primarily two figures are important concerning wireless networks: costs and the "Perceived Performance". What Andersson describes as "the measures that you can take in order to make the user feel

[63] Scalable Vector Graphics, an XML standard defined by the W3C [W3C02]

[64] Proprietary Application Programming Interfaces (APIs) are included in many handsets. Chapter 4.2 offers more insights into this topic.

[65] GATE stands for GPRS Application Test Environment, part of a service suite offered by Ericsson to simulate different network conditions in packet-switched networks

like the application performs well (the things that might not be possible to prove in figures but that still contribute to the overall performance)"[66] is actually what matters to most users. For the average mobile application end-user the protocols and network optimization used or the download data rate actually are fairly uninteresting.

Andersson suggests two measures: to keep the user in control and to keep the user informed. What helps a lot, for instance, is to provide the user with some meter informing about the download progress as simple as a few digits or a progress bar. Combined with interaction opportunities such as "online/offline mode", "cancel transfer" or "retry", users will forgive uneven network conditions more easily. Further measures include multithreading, i.e. transferring data between client and server in the background while allowing the user to continue using the application. A more sophisticated technique is intelligent data pre-fetching, which use is limited in mobile networks with volume-based traffic charges. Furthermore peer2peer transmissions or the use of memory cards[67] offer ways to overcome expensive airtime fees for downloading an application.

3.4.9 Controlling, Verifying and Informing

Keeping the user in control is critical for the success of any Smart Personalization measures applied to mobile applications. This paradigm starting with the first-time users, mobile application providers should ask for explicit opt-in. At this point, to inform the user about the advantages of enabling personalization and the usage of implicitly data can be useful. However, considering the limited screen real estate the length of this information needs to be adequate to the medium. Wherever possible, anonymous usage as well as non-personalized usage of a service should also be possible.

Adaptive techniques, as brilliant as they may be implemented, eventually are not able to read the user's mind. Instead they can only provide well-founded "intelligent guessing". That makes it essential to inform the user about the reason for the recommendations provided to him and to offer an opportunity to correct any critical guessing into the wrong direction. The user should be given a way to control the adaptive personalization offered, i.e. the user needs to be able to influ-

---

[66] Andersson, C. (2001). *GPRS and 3G Wireless Applications: professional developer's guide*. New York, NY, USA: John Wiley & Sons, Inc. p. 171.

[67] The Nokia N-Gage, for instance, offers the use of memory cards up to 128MB in size.

ence both, the results and the “smart” algorithms. Examples for controlling decisions with explicit input were given in chapter 3.3.3. In addition, indirect implicit verification should be used as well, taking time and HCI data into account. Not-selecting an action or leaving an area of the application very quickly also gives valuable feedback that a learning personalization engine can use.
Ideally, the verification process should not be limited to the users interacting with the system. In addition it should be the application provider’s duty to not simply deploy an application and “let it run”, but to constantly optimize the service in collaboration with the users. This ongoing process of improvement is an important part of adaptive applications being perceived by the users as Smart Personalization.

3.5 Architectural Issues

Depending on the supported types of personalization techniques and access channels, the system architectures or adaptive applications differ significantly. Because of that, this chapter only offers some general advice on selected architectural issues a provider of wireless applications should consider.
As a consequence of the different presentation formats being used on the mobile devices, the application needs to provide different output streams. Therefore a server-side separation of content data and presentation styles is advisable in order to flexibly support different access channels and varying device specifications (e.g. different screen sizes). A possible approach is to encode the content data in an XML format which then can be transformed to the respective destination format based on the user’s technical profile. Usually the provider would send the final document directly to the user’s device or to the operator’s WAP gateway. However, in some environments such as with applications provided for the Vodafone Live portal, an adaptation proxy is placed between the user and the application provider. The actual transformation adapting to the preferred presentation format is done by the proxy server which only receives the pure content without device-specific formatting from the application provider (e.g. a PartnerML document).
But a strict separation of content and presentation is not always possible. Smart Personalization often needs to consider and affect both, content and presentation parameters. Let us take an adaptive menu system as an example: To optimize the navigation within an application, the system tries to show selected action buttons or links according to the user’s display size. Depending on the device profile (e.g.

the number of text rows on the display) and as result of a Behavior-Based Analysis, the adaptive menu system provides an individual menu. As this example demonstrates, certain Smart Personalization techniques at least need to be aware of the technical profile to adapt the content accordingly. This obviously undermines the idea of a clear separation of content and presentation.

Most of the Smart Personalization techniques usually will be executed server-side. With client interfaces offering richer possibilities, however, parts of the adaptation processes can be performed client-side which can give the user server-independent control on the adaptation. Enhanced clients with additional local or personal area network connections (e.g. for communicating with other application users in the vicinity) offer advanced possibilities to process and enhance the Smart User Profile. This "new knowledge" then needs to be synchronized with the application server and with the master user profile in order to provide the new information to the adaptation techniques. A simple example for this type of "personalization-on-synchronization" is Avantgo, a service offering different content channels for download and synchronization with mobile devices such as Palm Pilots. One year ago I had subscribed to "LudiGames", a channel providing a text adventure called "Valdo and the Pirates". During the next synchronization one chapter of the text adventure was installed on my device. After tapping through all multiple-choice quests of the first episode, I was asked for a rating and whether I would like to play the next episode. Depending on my answer, the next synchronization would upload the corresponding episode to my PDA: a distributed system consisting of the LudiGames server, the AvantGo proxy server (who knows about the channels I have subscribed to), my desktop computer (which basically acts as a data gateway) and my PDA.

On the application provider's server side, a distributed architecture can also be employed to handle the user authorization. Microsoft .NET Passport authenticated applications for instance "outsource" the user authorization to a third party, to Microsoft's service. It remains an open question if users will be willing to use a central service such as Microsoft Passport (extended by additional smart profile parameters) for authentication towards various applications and for the convenience to have a portable profile across multiple access channels and networks.

3.6 Privacy and Personalization

With mobile data services still being relatively new to many users, privacy concerns about the security and usage of data are of high importance. Because especially new users will have problems with the idea to access their bank account "over the air with everybody listening" or to use an application which "knows" their current location, application providers need to be able to adapt their service to individual privacy demands.

In terms of legal requirements, providers of adaptive mobile applications face a set of strict regulations today. Kobsa[68] offers a sample list of restrictions from the German Teleservices Date Protection Act and a European Data Protection Directive which "substantially affect the internal operation of personalized hypermedia applications". Since the release of Kobsa's paper, the Directive 2002/58/EC on privacy and electronic communications has been published by the European Parliament and of the Council of 12 July 2002[69] which repeals and replaces Directive 97/66/EC. Considering recent developments in the markets and technologies for electronic communication services, the new directive addresses issues such as collecting and processing of personal, location and traffic data, which directly relates to the possibilities to offering Smart Personalized mobile applications. 2002/58/EC uses the term "value added services" for this kind of advanced applications.

Advocating usability and privacy, the central elements proposed by the EU directive are very user-centered. In addition to keeping the user informed in a clear and distinctive manner[70], applications should provide sufficient opt-out opportunities[71], also temporary ones, which need to be accessible free of charge. This especially refers to location based services and mobile marketing opportunities.

---

[68] Kobsa, A. (2002). Personalized hypermedia and international privacy. *Communications of the ACM*, 45 (5). New York, NY, USA: ACM Press. pp. 64-67.

[69] EU (2002). Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications). *Official Journal L 201, 31/07/2002.* pp. 37-47. Available via <http://europa.eu.int/comm/internal_market/en/dataprot/law/index.htm> [Accessed: 23 February 2003]

[70] 2002/58/EC suggests that "Service providers should always keep subscribers informed of the types of data they are processing and the purposes and duration for which this is done."

[71] 2002/58/EC proposes that "This opportunity should continue to be offered with each subsequent direct marketing message, free of charge, except for any costs for the transmission of this refusal."

Enabling advanced personalized techniques such as those discussed in chapter 3.4 may only be allowed "if the subscriber has agreed to this on the basis of accurate and full information given by the provider of the publicly available electronic communications services about the types of further processing it intends to perform and about the subscriber's right not to give or to withdraw his/her consent to such processing."[72] This requirement causes actual problems with adaptive wireless applications for limited devices. On the web it is feasible to display the privacy policies in full-text to the user. With extremely restricted screen sizes and expensive mobile networks, however, this task becomes nearly impossible, particularly with regard to SMS-based services.

Based on the "price of convenience", Ng-Kruelle et al.[73] offer a framework to understand how a user trades personal privacy for the conveniences of mobile technology. Their paper also examines the dynamics of privacy sensitivity over time. Because the individual nature of privacy requirements this thesis suggest that applications should consider individual privacy preferences. Emerging standards such as the Platform for Privacy Preferences (P3P)[74] driven by the World Wide Web Consortium could assist in creating an automated filtering process of a the user's profile. Osbakk and Ryan[75] sketch out how a P3P-driven level of clearance could be achieved with a combined CC/PP profile[76] containing device profile, context and privacy preferences[77]. Today users are basically offered proprietary

[72] 2002/58/EC preamble #26

[73] Ng-Kruelle, G., et al. (2002). *Price of Convenience: Dynamics of Adoption Attitudes and Privacy Sensitivity Over Time.* CollECTeR 2002, Melbourne, Australia, December 1-2, 2002 <http://apache.iwi.uni-koblenz.de:8080/iwi/marc/publications/poc-Melbourne.pdf> [Accessed: 15 January 2003].

[74] Marchiori, M. (2002). *The Platform for Privacy Preferences 1.0 (P3P1.0) Specification.* W3C Recommendation 16 April 2002. <http://www.w3.org/TR/P3P/> [Accessed: 23 February 2003]

[75] Osbakk, P., Ryan, N. (2002). Context, CC/PP, and P3P. *UbiComp 2002 Adjunct Proceedings.* Göteborg, Sweden: Viktoria Institute. pp. 9-10. <http://www.cs.ukc.ac.uk/pubs/2002/1553> [Accessed: 23 February 2003]

[76] More information about the Composite Capabilities/Preferences Profile (CC/PP) Working Group can be found at <http://www.w3.org/Mobile/CCPP/> [Accessed: 23 February 2003]

[77] The combined CC/PP profile which is suggested by Osbakk and Ryan is in a way similar to the smart user profile proposed in this thesis. However, Osbakk and Ryan provide no further details on the way the particular preferences could be actually implemented. As of now, CC/PP profiles are primarily used for describing device capabilities only. The WAP UAProf introduced in chapter 3.2.4 is the first large-scale deployment of CC/PP.

solutions by application providers or mobile network operators. Customers of Vodafone D2, for instance, can configure the availability of location data to mobile applications in the customer service area within the Vodafone website.

Another part of privacy includes technical and organizational security measures which must be implemented to protect personal data and other pieces of information stored in the Smart User Profiles. Security requirements are discussed in chapter 4.6.

4 Enabling Technologies for Smart Personalization

This chapter focuses on technologies enabling Smart Personalization. I will presents and discuss important standards being in use today with a critical view on the possibilities and problems associated with the corresponding technology with regard to user-centric Smart Personalization.

4.1 Mobile Markup and Scripting Languages

Mobile markup and scripting languages enable Smart Personalization at the "first inch". They are authoring languages for content and client-side functionalities targeted at resource-constrained devices. From the standpoint of mobile application developers, the following three markup languages are important today:

- cHTML
- WML
- XHTML MP

Compact HTML (cHTML) is the language being used by i-mode cell phones. Pushed by NTT DoCoMo and proposed to W3C in 1998, cHTML can be seen as a reduced version of HTML making it easy for web application developers to create mobile services. It offers basic formatting features (e.g. "<font color=…"), however direct control on the actual output is very limited. As a scripting language is also missing, cHTML is not more than a simple presentation markup language, which is widely supported by handsets primarily in Japan.

WML, the Wireless Markup Language supported by the WAP Forum / Open Mobile Alliance, is based on XML and was created especially for use on constrained wireless devices. In contrast to cHTML, WML enabled micro-browsers usually support WMLScript, a simple scripting language similar to JavaScript enabling dynamic WML and simple calculation or client-side form validations. Particularly interesting for adaptive applications is the Wireless Telephony Application Interface (WTAI), whose functions can be invoked via WML or WMLScript. This way applications for WAP enabled devices can initiate calls or add entries to the user's telephone directory.
XHTML Basic is a very reduced content authoring language designed for use by limited Web clients such as mobile phones or PDAs. It has been extended by the WAP Forum / Open Mobile Alliance in form of the *XHTML Mobile Profile* Specifications[78], which add presentation attributes and tags as well as WCSS (WAP Cascading Style Sheets, a subset of CSS2 with WAP-specific extensions).

From today's perspective, XHTML as a merger of cHTML and WML will most likely become the standard base mobile application providers can rely on in the future. However, in order to provide users with the best possible experience, developers should not only adapt their applications to the available standards but especially test the "look&feel" on actual end-devices. The past and even devices being launched today have shown that standards are often implemented only partially or poorly[79]. Because of the limitations and lack of support of client-side scripting languages, adaptive techniques will in most cases be server-driven.

To complete this brief overview I will mention three more important standards: Voice XML is a widely acknowledged standard for supporting voice and touch tone interfaces for information systems. Additional mobile presentation languages include SVG mobile profile, which has not been widely implemented yet but could be interesting because its capabilities to adapt to different screen sizes. Also Macromedia Flash, which might play an important role with its ActionScript sup-

[78] WAP Forum, Ltd. (2001b) *XHTML Mobile Profile*. Version 29-Oct-2001. <http://www1.wapforum.org/tech/documents/WAP-277-XHTMLMP-20011029-a.pdf> [Accessed: 13 February 2003]

[79] During the creation of my WAP prototypes I came across the lack of WTAI support in various Nokia mobile phones. The variety of different WML versions also challenges mobile application developers, to give only two examples at this point.

port on more powerful end-devices, is a "scalable" standard with players currently being available for Symbian OS and Microsoft Pocket PC 2002. Macromedia and NTT DoCoMo recently have announced the embedding of Flash technology into the new i-mode handsets scheduled for release later in 2003.[80]

4.2 Mobile Runtime Environments

Mobile Runtime Environments provide a common ground for application developers across different devices and operating systems. "Develop once, run anywhere!" is the claim that Runtime Environments offer as an advantage over native applications being compiled for a particular operating system. Popular Environments of relevance to application providers today are the Java 2 Micro Edition (J2ME) plus various extensions and the Binary Runtime Environment for Wireless (BREW) by QUALCOMM, which is based on C/C++. Currently BREW is especially popular in Northern America.

With J2ME being a scaled-down Java version, different "configurations" exist, whereas I will focus on the Connected, Limited Device Configuration Specification (CLDC), which is intended for resource-constrained environments such as mobile phones and PDAs. On top of CLDC, a "profile" gives further definitions (i.e. provides additional classes) for user interfaces and storage, for instance. A popular profile supported by a variety of handsets today is the Mobile Information Device Profile (MIDP).
Persistent storage in MIDP is centered around so-called record stores, which essentially are small databases that can contain pieces of data called records[81], which are being stored on the user's end-device. While in MIDP 1.0 the possibilities to write network-connected MIDlets[82] are limited to HTTP, the MIDP 2.0 specification will address several new areas including security and HTTPS support as well as socket connectivity. However, with MIDP 1.0 a better level of security can be reached as well by using additional cryptography packages such as the light-

[80] The corresponding press release „NTT DoCoMo to Enbed Macromedia Flash Technology into i-mode Service" can be found at <http://www.macromedia.com/macromedia/proom/pr/2003/ntt_docomo.html> [Accessed: 24 February 2003]

[81] Knudsen, J. (2001). *Wireless Java™: Developing with Java 2, Micro Edition.* Berkeley, CA, USA: Apress. gives some good details and examples for working with record stores (p. 77)

[82] MIDlets are small applications conform to Mobile Information Device Profile (MIDP).

weight open-source API *Bouncy Castle Crypto Package*[83]. As I will discuss in chapter 4.6, security is an important aspect which users are concerned about when giving away their personal data.
The DoJa API, which is pushed by NTT DoCoMo, has been implemented in a variety of i-mode handsets and follows a similar concept as MIDP. However, it offers different classes and makes a few more specifications to the CLDC such as limiting the file-size of an i-appli jar file[84] to 10KB. As counterpart to the MIDP record stores the DoJa API allows i-applis to store up to 5KB of data in a storage area on the client device called "the ScratchPad".

The differences between these two CLDC implementations are multiplied by a diversity of proprietary device manufacturer APIs built into the handsets. Also BREW-enabled devices ship with proprietary vendor-specific extensions. These APIs offer additional functionalities and access rights enabling applications to utilize and adapt to special features such as accessing the calendar and address book, sending an SMS or taking pictures with a built-in camera. The downside of these benefits is that the implementations are more elaborate and costly. With Nokia devices, for instance, sound functions are located in proprietary "com.nokia.mid. sound.*" APIs as shown in Code example 6. IBM's Java Virtual Machine, which is integrated in BREW-enabled handsets to allow the execution of J2ME applications within BREW as well, tries to contain the variety of proprietary extensions by functioning as "the 'lowest common denominator' to smooth the way for Java applications"[85].

[83] The latest versions of *Bouncy Castle* are available from <http://www.bouncycastle.org/> [Accessed: 15 January 2003]. Knudsen (2001) also gives some implementation examples in *Wireless Java™: Developing with Java 2, Micro Edition.* p. 157 and pp. 166-175.

[84] i-appli is the name of Java applications based on the DoJa API, usually stored in a Java Archive file format (JAR)

[85] QUALCOMM (2002). *The Road to Profit is Paved with Data Revenue. QUALCOMM Internet Services White Paper June 2002.* <http://www.qualcomm.com/brew/about/brewwhitepaper.pdf> [Accessed: 3 January 2003] p. 14.

```
1   private static TonePlayer makeTonePlayer()
2   {
3     TonePlayer player;
4
5     try
6     {
7       // This statement throws an exception if no Nokia UI API
available
8       Class.forName("com.nokia.mid.sound.Sound");
9       // If we get here, Nokia UI API is available, so we can
safely
10      // create a player that uses it. But we use Class.forName
rather
11      // than 'new' so that there is no link dependency.
12      Class clas =
Class.forName("example.tones.NokiaTonePlayer");
13      player = (TonePlayer)(clas.newInstance());
14    }
15    catch (Exception e)
16    {
17      // If no Nokia UI API, then create a dummy tone player
18      player = new TonePlayer();
19    }
20
21    return player;
22  }
```

Code 6: Example for proprietary APIs – Java sound libraries for Nokia mobile phones[86].

To summarize, applications being executed in Runtime Environments on the mobile clients enable additional client-side "intelligence" supporting Smart Personalization. Exceeding the possibilities of solely browser-based interfaces, J2ME or BREW applications provide the following advantages:

- Small applications residing on the client
- Download once, use multiple times (without extra network traffic)
- Storage of (small pieces of) data on the client
- Enabling advanced user interfaces facilitating deeper interactions
- Limited access to other applications and data
- Limited access to APIs for using device specific functions
- Limited cryptographic possibilities

Towards implementing adaptive personalization techniques, these features sound very appealing. Enabling a unique user identification without explicit input by storing an identification token on the mobile end-device is very convenient for

[86] Code is based on an example provided by forum.nokia.com

the user. Functions for dynamic layouts (as discussed in chapter 3.4.7) are available providing an adaptive user-friendly interface, which is able to record and learn from the user's input in more detail than it would be possible with browser-based applications[87].

4.3 Mobile Operating Systems

Relevant mobile operating systems being in use on today's mobile terminals include Palm OS, Symbian OS and Microsoft Windows CE. In contrast to applications executed in the "sandbox" of a Mobile Runtime Environment, a native application written and compiled for a mobile operating system virtually has access to all data and to the whole device. This means, that technically there are no restrictions in using additional air interfaces such as Bluetooth[88] or accessing secondary data sources such as location data or the user's calendar.

The strength of *Palm OS* powered devices traditionally is to offer a stable platform for standard applications such as "Address", "Date Book", "Expense", "Memo Pad" and "To Do List". Palm OS 3.0 was released with the Palm III PDA in 1998. A drawback often criticized with Palm OS has been the lack of multithreading capabilities, which for example prohibited applications to query or synchronize data in the background for providing a smooth user experience[89]. This has changed with Palm OS 5 shipping with multitasking / multithreading capabilities, standard security libraries and Wireless LAN support.
Microsoft Windows CE, which stands for compact edition, is the foundation which other Microsoft "go-to-market solution" groups build on. The Microsoft Pocket PC 2002 platform or the Microsoft Smartphone platform are prominent users of Microsoft Windows CE. Similarly to the desktop Windows releases, users are able to customize their Pocket PC 2002 with "themes", allowing them to put custom background images or to change the color scheme and sound alerts. In addition an adjustable "Today Screen" enables users to configure which information they

[87] For instance, a personalization engine would not be able to monitor a user scrolling or switching between different "cards" within one WML page. Within a client-side application, however, this kind of information can be recorded and used for shaping the user's smart profile.

[88] Motorola has been creating a reference implementation of a Bluetooth API (JSR-82) for J2ME. However, this API still is a CLDC optional package.

[89] Also see chapter 3.4.8: "Adapting to Wireless Networks".

want to see when they turn on the device. Beyond these simple explicit personalizations, also computing-intensive, implicit personalization techniques can be implemented client-side, which is made possible by the usually strong computing resources available on Windows CE devices due to the relative resource-hungry operating system. Although not considered being a mature platform yet, the number of Windows CE based devices is increasing[90].

Symbian OS has evolved of a joint venture formed by Ericsson, Motorola, Nokia and Matsushita (Panasonic) as well as Psion contributing EPOC, which was the software basis. Today, Symbian OS is licensed by the world's leading mobile phone manufacturers integrating computing and telephony services. Based on Symbian 6.1, Nokia has defined the Series 60 Platform, a complete Smartphone reference design providing developers with a standardized application environment. Features include common screen size, input methods, APIs and UI libraries. Based on this standard, application providers can offer relatively complex and well-performing personalized applications to a broader user base.

Native applications enable intelligent, rich clients making maximum use of the available resources. Depending on the needs and the type of application (i.e. whether it will be an enterprise application running on a set of specified devices or a mainstream application being deployed to a variety of platforms and devices), the developers will consider carefully whether the project needs (multiple) native applications or probably a runtime solution is sufficient.

4.4 Mobile Networks and Services

Another important decision to make by the mobile application developers is to answer the question which network interfaces and protocols the application should utilize. The following chapters will light up relevant standards and air interfaces.

4.4.1 Mobile data in GSM networks

Not so long ago basically all connections within Global System for Mobile Communications (GSM) networks were calculated in "airtime". What was suitable for mobile phone calls quickly became a problem with data services raising costs by

[90] <http://www.msmobiles.com/> gives a good overview on the devices currently available.

the minute of usage as well, which definitely is no model the users appreciate. However, it is the traditional way of charging for services the mobile network operators are used to, who are often evolved fixed-line telecommunication providers. In Japan, NTT DoCoMo started their i-mode service very early back in February 1999 with introducing packet-switched networks (packed-switched PDC-P). This strategic decision enabled them to charge i-mode users by data traffic and not by "airtime" and to send e-mail push messages directly to the handsets. I agree with Wallace et al.[91] that "the choice of a packet-based 'always-on' network surely has been one of the critical success factors of i-mode" in Japan.

Many European operators unfortunately do not seem to commit themselves to offering affordable access to packet-switched mobile data yet. High Speed Circuit Switched Data (HSCSD), a protocol bundling two or more GSM channels for faster data traffic, is being promoted by E-Plus and O2 Germany as the transport of choice for downloading "larger" files such as email attachments. Interesting enough: even for users without HSCSD devices it is cheaper to use an old 9,6 Kbit/sec GSM circuit switched data connection for downloading as less as 0,5 MB of data than paying for the expensive packet switched traffic at the same MNO. Finally introduced in 2001 by all GSM network operators in Germany (T-Mobile, Vodafone D2, E-Plus, O2), General Packet Radio Service (GPRS) is being charged by volume in contrast to call-based CSD or HSCSD. This late move could be noticed in other European countries as well.

Maybe because "the telecommunication providers are only slowly beginning to understand what packets are", as a session during the "Chaos Communication Congress 2002"[92] satirized, a strong support for mobile data users is not omnipresent yet. For visualizing the pricing discrepancy between packet data and circuit switched based data occupying one or more full GSM channels, I have compiled the following table. Although the calculations do not take into account required header, session or flow control data and the fact that 1MB of data should never be transported via Short Messaging Service (SMS), the numbers give a good idea of the relations and implications of today's mobile data pricing policies of German MNOs in specific:

---

[91] Wallace, P., et al. (2002). *i-Mode Developer's Guide.* Boston, MA, USA: Addison-Wessley. p. 17

[92] Chaos Computer Club (2002). *Security Nightmares III: Worüber wir nächstes Jahr lachen werden.* Presentation at 19th Chaos Communication Congress "Out Of Order". Berlin, Germany. 27-29 December 2002.

Transport	Bandwidth net	Fees (examples)	Duration for 1MB net	Cost for 1MB net
GSM CSD	9,6 Kbit/sec	€ 0,10 / min	853 sec.	€ 1,50
HSCSD (Vodafone D2)	28,8 Kbit/sec	€ 0,19 / min	289 sec.	€ 0,95
HSCSD (E-Plus)	56,6 Kbit/sec	€ 0,10 / min + € 7,50 / month	145 sec.	€ 0,30 + monthly fee
GPRS (O2 Germany)	26,8 Kbit/sec	€ 0,05 / 10KByte + € 0,25 / day	306 sec.	€ 5,15 + fee per day of use
MMS	100 KByte/MMS	€ 1,29 / MMS	11 MMS	€ 14,19
SMS	160 Bytes/SMS	€ 0,19 / SMS	6554 SMS	€ 1245,26
fixed-line 28,8K Modem	28,8 Kbit/sec	€ 0,0133 / min	289 sec.	€ 0,07

Table 2: Comparison of different transport protocols in GSM networks, based on January 2003 pricings of German MNOs.

For the mobile application provider these pricing policies mean that at the moment it does not make sense to offer applications generating high data volumes to the users because customers would not accept such services causing eventually very high fees. From the revenue perspective there is also no motivation for mobile application providers to generate high traffic volumes because no revenue sharing models in terms of packet traffic revenue sharing between MNOs and mobile application providers exist. Some experts argue that such kind of model would be desirable[93]. From my point of view, however, the current models (monthly subscription fee or pay per purchase) motivate the content providers to offer more affordable and low-traffic services to the user. So Smart Personalization in the context of different transport channels means for the application provider to choose the best possible channel mix for the best customer experience regarding speed, traffic fees and convenience which can be achieved by optimizing the application size and application data. The best choice in most situations actually could be to reduce the MNO costs to the absolute minimum. In the following chapters I am introducing some technologies facilitating a smarter channel mix. For more details about perceived speed please also see chapter 3.4.8.

[93] Funk, J.L. (2001). *The Mobile Internet: How Japan dialed up and the West disconnected.* Kobe, Japan: ISI Publications Limited. p. 42.

4.4.2 Wireless Personal Area Networks

With small distance Wireless Personal Area Networks (WPANs) two prominent standards are in use today: IrDA and Bluetooth. The following introduces some examples of personalized applications for each standard and gives a feature comparison at the end.

The first version of *IrDA* had been developed by the Infrared Data Association and was standardized back in 1994 already. Offering easy-to-use infrared data exchange, IrDA interfaces are implemented in many PDAs, portables, mobile phones and even desktop printers today. IrDA is in use in point-to-point scenarios where data needs to be synchronized (e.g. Palm computer address book with Portable PC Outlook), transferred (e.g. downloading an exhibition map from IrDA equipped kiosk terminals) and also where actions are triggered by IrDA signals (e.g. point-based triggering in chapter 3.2.2). Due to the nature of infrared signals, sender and receiver need to be within sight of each other with no obstacles in between. Because of that, IrDA communication is usually established explicitly by the user.

The *Bluetooth* radio data standard with version 1.0 was defined in 1999, larger amounts of devices are available to consumers since 2000. Today more and more mobile phones, portable computers and PDAs are factory-equipped with Bluetooth capabilities. In contrast to IrDA, Bluetooth offers point-to-multipoint communication from the first version on including the ability to establish Piconets (network consisting of two to eight Bluetooth devices communicating with each other) and even Piconets linked together, so called Scatternets.

These constellations enable application developers to not only implement simple one-to-one data synchronization and transmission facilities but to deploy dynamic peer-to-peer networks. Adaptive personalization benefits mainly from the local aspect and from the inexpensive pricing of these kind of ad-hoc-networks. Location sensitive data, such as geographic distance between the peers (relative location), the geographical area of the scatternet (absolute position, probably provided by a fixed-position Master device) but also pieces of information that might be of interest to the peers can be distributed at virtually no costs (no traffic charges).

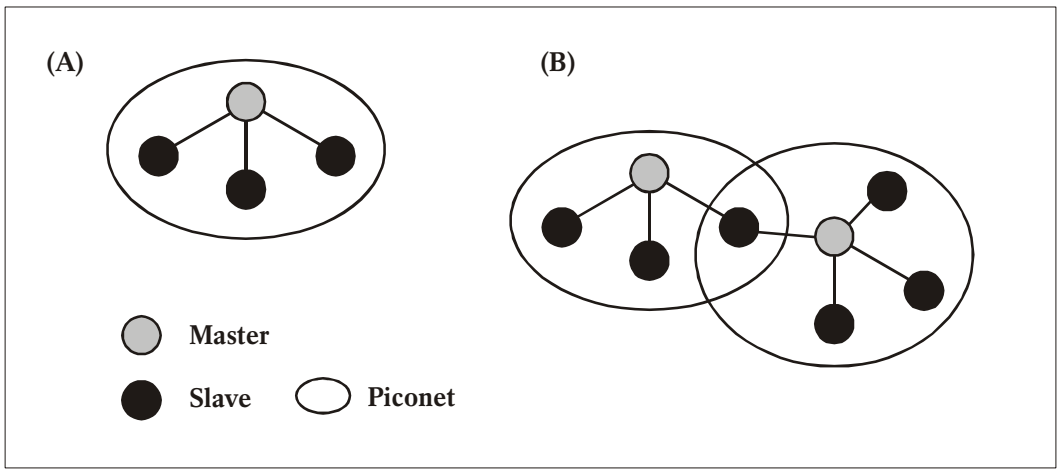


Figure 5: (A) Piconet and (B) Scatternet with one Slave belonging to different Piconets.[94]

In the automotive sector peer-to-peer applications are being evaluated for traffic jam warnings or automatic parking spot reservation along with dynamic routing. Because the Bluetooth standard is supported by many device manufacturers we can expect more and more devices also being available in the mass-market. Nokia's Bluetooth enabled gaming mobile phone "N-Gage" is expected to hit the stores in Q4 2003 offering wireless multi-player gaming in remote (via GPRS) but in particular within personal area ad-hoc networks. Therewith new exciting Smart Personalization becomes possible such as the following challenging message:

```
Player Bambi, rank 45 of the SonicWireless Berlin league, is
within your Bluetooth reach. You are rank 49 and have activated
Ask4Challenge. Do you want to compete now or schedule a match?
```

Code 7: Bluetooth ad-hoc networks could enabled this kind of personalized mobile service.

[94] Similar figures are provided in Roth, J. (2002). *Mobile Computing. Grundlagen, Technik, Konzepte.* Heidelberg, Germany: dpunkt.verlag GmbH, p. 147.

The following table summarizes the main differences of IrDA and Bluetooth Personal Area Networks with specific regard to enabling Smart Personalization:

Property	IrDA	Bluetooth
Type of transmission	Infrared	Radio
Working distance	~ a few meters between two mobile devices within sight of each other with no obstacles in between.	up to 10 or 100 meters
Connection between two devices	Only if logical connections are established (IrLMP)	When Devices are in transmission range
Access method	Master/Slave, low-end devices can be slave-only	Master/Slave, each device must have master capabilities
End-device penetration	Most PDAs and upper-class Smartphones, growing	Still higher-end devices, but growing rapidly with consumer devices, too
Point-to-Multipoint	Not in IrLAP version 1.1	Yes
Reliable bi-directional transmission of data	Yes	Yes
Reservation of bandwidth resources possible	No	Yes (e.g. for audio data)
Overlapping of networks	No	Scatternet
Gross data rate	Variable: 2,4 kBit/s up to 16Mbit/s	Fixed: 1 Mbit/s
Authentication and encryption	No	Yes (LMP)

Table 3: Comparison of important IrDA and Bluetooth Properties[95].

4.4.3 3G and Beyond: Fast and Hybrid

UMTS, 3G, 3G beyond, next-generation wireless networks, all-IP and many more buzzwords are circulating in the media more than ever during these months. European MNOs have spent approximately 100 Billion Euros during the frequency slot auctions and are to spend approximately the same amount again for setting up the required "UMTS infrastructure". With UMTS, which stands for *Universal Mobile Telecommunication Standard*, many people might associate designer mobile phones with large color displays, video phoning and broadband downloading as well as global access. Although global roaming in fact is an aim of

[95] Parts of the table contained in Roth, J. (2002). *Mobile Computing. Grundlagen, Technik, Konzepte*. Heidelberg, Germany: dpunkt.verlag GmbH, p. 168.

UMTS, in May 2000 the ITU[96] proposed five different air interfaces for the 3rd generation mobile telecommunication standard "IMT-2000", which was renamed to UMTS. In terms of transmission speeds, the standards being implemented in Europe will offer a maximum downstream of 2 Mbit/sec. which is a theoretical figure that could only be reached in "Hotspots" with a high cell density. Upcoming end-devices, however, will only support download rates up to 385 Kbit/sec. From the perspective of Smart Personalization, two UMTS properties are of particular interest: Quality of Service and Virtual Home Environment.

UMTS allows four different classes of Quality of Service (Conversational, Streaming, Interactive and Background). Depending on the type of data which needs to be transmitted and the duration, throughput and latency requirements, adaptive applications should be able to choose the appropriate service level on behalf of the user. Although the European MNOs are still very diffident about UMTS pricings, the introduction of QoS-dependent pricing systems is most likely. Therefore Smart Personalization can help to optimize the network service costs for the user.

The idea behind the Virtual Home Environment (VHE) is that users should be provided with the same application service and computing environment on the road and in foreign networks that they have in their home network. Unfortunately IMT-2000 does not offer much more concretization of the term VHE. In connection with the Smart User Profile outlined in this thesis, VHE could incorporate different application specific Smart User Profiles in one common environment. Research is in progress by the Fraunhofer Virtual Home Environment project[97] and other groups to translate this vague concept into functional prototypes. It is hoped that these efforts can contribute specifications and standardizations resulting in available open implementations of a user-centered VHE.

Another concept of UMTS is seamless roaming and handover across different air-interfaces including mobile networks of the second generation, e.g. GSM. Based on the IEEE 802.11 standards, whole cities can be covered with relatively cheap and fast (11 MBit/sec up to 54 MBit/sec) mobile networks[98]. Besides independent early-adopters now enterprises such as AT&T are trying to make their profits with

---

[96] International Telecommunication Union

[97] Public prototypes will be presented during CeBIT 2003. An overview on the Virtual Home Environment group can be found at <http://www.isst.fhg.de/english/projekte/2002/VHE.html>

[98] Siegel gives insights on the current state of WiFi networks in the United States in Siegle, J. A. (2003). WLAN-Datenfunk als UMTS-Alternative. Generation WiFi. *Internet Professionell.* 3/2003. Munich, Germany: VNU Business Publications Deutschland GmbH. pp. 88-90.

the deployment of comprehensive WiFi coverage of major cities. For the users and application developers this trend provides major advantages as cheaper always-on rich media applications become possible. For Smart Personalization an increased competition should lead to the easier availability of high-quality Smart Factors such as location data and enhanced possibilities to utilize client-server communications. A problem to be solved soon, however, is the relatively high power consumption of WiFi-cards which currently limits the active usage time of WiFi-based PDAs to approximately 100 minutes.

One more important standard adds up to the variety of possible new air interfaces. In the city of Berlin the formerly analog terrestrial TV signals are currently being moved to the Digital Video Broadcast standard (DVB-T). This process will be completed by end of Q3 2003. Researchers have expressed interest in using the frequency slots now available again for hybrid network field studies. Possible scenarios approached by FhG FOKUS Research Institute for Open Communication Systems[99] include hybrid networks consisting of W-LAN in hotspot areas and UMTS combined with DVB-T downstream outside of hotspots. This combination could make it possible to combine broadcast application downloads and video streams with individually personalized bidirectional data.

4.4.4 Mobile Messaging

By including mobile messaging functionalities, mobile applications providers can add push functionality to their services. This means that an application can send a message to a mobile user without an explicit request from the user at the time the message is delivered. Smart personalization in this area includes the challenge to choose the best fitting push messaging format for each user's context and adapting the content accordingly.

Examining mobile messaging formats, the standard with the biggest user based is clearly SMS (100% among GSM phones). The Short Messaging Format was originally meant to be used as a simple notification for new calls left on the user's mailbox. Although of the new emerging standards, SMS with its 160 characters maximum length still is a widely accepted communication channel among the users. I-mail is a standard connected with NTT DoCoMo's i-mode service. The mobile email give users the ability to writer larger messages than SMS users, which is

[99] FOKUS currently operates a "UMTS Testbed" in Berlin, Germany. http://www.fokus.fhg.de/

the reason why a variety of personalized i-mail newsletters is available. Another success factor of i-mail is the ability to include small pictograms in a message. These emojis (icons, which can be included within regular text) give users an easy way to express their feelings in small pictures[100] resulting in more personal messages.

To overcome the limitations of SMS, the Multimedia Message Service (MMS) is supported by many MNOs and device manufacturers. Still users are experiencing difficulties with MMS because of different media formats supported by different handsets and problems with sending an MMS between networks of different operators.

In addition to these original mobile messaging formats[101], the classic e-mail known from the fixed-line internet is emerging to more and more mobile devices, primarily PDAs and upper-class mobile phones with built-in email clients. This offers attractive possibilities to personalized application providers to use a free medium as a back-communication channel to mobile users. Also direct links can be included which send a user directly to a specific area within the application avoiding additional navigation and login, for instance.

The WAP Push specifications[102] define a promising concept towards more direct data provisioning for mobile applications. However, this standard is not significantly supported by current MNO gateways and devices yet. An important role in cross-channel applications might also play instant messaging formats[103] which are very popular on the fixed-line internet. Efforts are on its way to deploy clients and additional services on mobile devices as well. Here also smart and optimized protocols are needed for enabling low-traffic messaging especially taking into account the price factor of data mobile communication from the user's point of view.

---

[100] In E-Mails and SMS messages users include combinations of regular characters instead such as ;-)

[101] Although SMS usage is possible on specific landline phones as well (i.e. with Deutsche Telekom), the number of fixed-line SMS users is not significant yet.

[102] WAP Push contains a set of specifications. The basic concept is discussed in: WAP Forum, Ltd. (2001a) *WAP Push Architectural Overview*. Version 03-Jul-2001. <http://www1.wapforum.org/tech/documents/WAP-250-PushArchOverview-20010703-a.pdf> [Accessed: 13 February 2003]

[103] Relevant user bases are available with AOL IM, ICQ, MSN Messenger and Y! Messenger.

4.5 Mobile Devices

Taking a look at the announced and currently available mobile devices shows that the possibilities to offer advanced applications to a broad user base are increasing rapidly. While two years ago the deployment of client-side applications was basically limited to PDAs, the majority of mobile phones being announced by manufacturers such as Nokia and Siemens today supports at least Java MIDP 1.0. With the raising acceptance of MMS, the number of color display and camera phones is increasing with additional support by extensive MMS or Vodafone Live! marketing campaigns. From the mobile application designer's perspective a wide range of different screen sizes exists underlining the need of adaptive presentation layers. Although the Series 60 Platform supported by Nokia and recently by Siemens as well increases the penetration rate of a specific screen size in the market, the variety of available display resolutions is to high to stick to a fixed size layout. Also with PDAs different screen sizes and color depths are in use mostly resulting in adapted versions of a particular application.
With the input facilities provided by the different mobile devices the situation is similarly diverse: The variety ranges from numeric pad and one button WAP navigation as on the Nokia 3330 up to full keyboard devices such as the Nokia 9210. Also additional input tools such as programmable soft keys, sticks and navigation wheels are in used which well personalized applications could detect and support. Also special application devices are available such as Vitaphone[104], a mobile phone featuring heart rate measurements.

4.6 Security and Personalization

Similarly to the concepts introduced in "Adapting to Wireless Networks" (chapter 3.4.8), with security we can differentiate between actual security and perceived security. Both should be oriented on the level of security required based the weight and types of transactions and smart profile properties being used.

Transport security ideally should be realized as a seamless end-to-end security layer on top of the actual personalization data being exchanged between the user's end-device and the mobile application provider. This includes ensuring security in terms of integrity (i.e. the data is not getting changed or corrupted), au-

[104] More information about Vitaphone is available in German only at <http://www.vitaphone.de/>

thentication (i.e. including a way to identify the user) and confidentiality (other people should not be able to see one user's personal information). With end-device and server implementations being based on the same protocol stack, a seamless transport security layer is well feasible, for example in form of the Transport Layer Security (TLS) in the TCP/IP world. In WAP 1.x scenarios, however, the communication between end-device and WAP gateway will be protected based on Wireless Transport Layer Security (WTLS) as part of the WAP protocols. A possible security flaw therefore exists at the WAP gateway, which needs to encode and convert between these two security protocols while internally having the transported content unprotected for a brief moment.

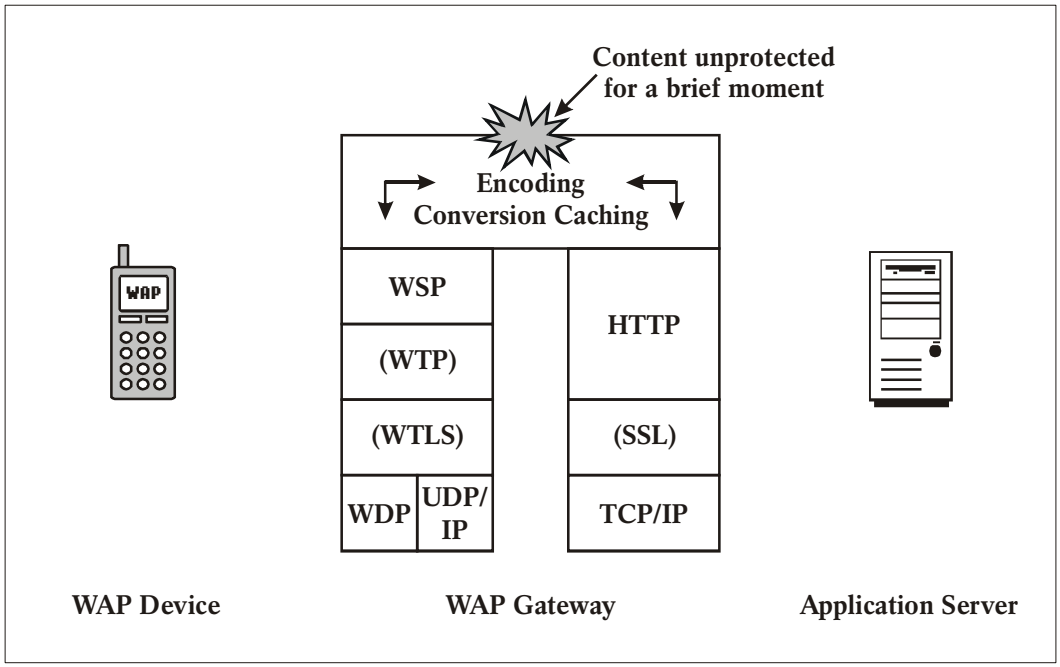


Figure 6: WAP gateway anatomy with a security flaw[105].

Especially with applications that have high security requirements such as mobile banking or mobile brokerage, the providers (i.e. the banks) prefer to maintain their own WAP gateway within secured in-house networks.

Over-the-air (OTA) application provisioning is another area of increased security concerns besides personalization and transaction data security. Being of particular use for downloading smaller-sized applications, OTA provisioning of J2ME

[105] Figure according to Andersson, C. (2001). *GPRS and 3G Wireless Applications: professional developer's guide*. New York, NY, USA: John Wiley & Sons, Inc. p. 248.

MIDlets currently uses unencrypted HTTP connections. MIDP 2.0 with HTTPS support is a major step of improvement in this area. However, a significant number of available devices supporting MIDP 2.0 is needed for enabling secure downloads of truly personalized application versions, possibly with integrated authorization keys and personal identifiers.

On the backend side an appropriate level of data storage security is needed. Protecting the valuable Smart User Profile data with adequate software and encryption measures should go along with the application provider ensuring a decent level of organizational and physical security. This includes redundant data storage and regular off-site backups as well as restricted virtual and physical access to the profile server limited to authorized staff only.

5 MIX – Prototyping Smart Personalization

The following subchapters outline, describe and discuss the prototype applications I have been developing in cooperation with the Berlin based Mobile Economy GmbH throughout this thesis.

5.1 MIX 1.0

MIX stands for "Mobile Information eXchange". Version 1.0 of MIX was created back in the year 2000 by Mobile Economy GmbH as a mobile people matchmaking application. Users were able to search for other users and chat with them using the MIX 1.0 anonymous SMS interface as a "gateway" into this progressive mobile dating and messaging application.
Although the application was fully functional, the project was put on hold because of two reasons. As discussed in chapter 2.1, all German MNOs had increased the MT SMS pricing to a level which made it very hard to run an advertisement-driven service based on SMS[106]. Also from the user's perspective the high MO SMS price is a barrier to using an application such as MIX 1.0. In addition, usa-

[106] Mobile Terminated (MT) SMS pricing currently is around € 0,06 per SMS sent from a server. Therefore basically only the MNOs themselves are able to run advertisement driven services based on SMS.

bility problems with regular users accessing the short command user interface were bigger than expected. Field tests, which were videotaped[107] in public places like restaurants and on the street, demonstrated that users had significant problems with registering and searching for other users.

```
S F 20-30 B
```

Code 8: "Cryptic" MIX 1.0 codes – this SMS initiates a search for female users located in Berlin (B is the license plate code) between 20 and 30 years old.

While a SMS-only interface is useful for simple pull applications with single actions (e.g. "NEWS BAYERN MÜNCHEN" to receive the latest soccer club news), more complex tasks are hard to perform through SMS alone.
One possible solution is a multi-channel application. By setting up preferences such as preferred search city, gender and age on a web interface, for instance, a simple command could perform a multi-parameter task.

```
SEARCH
```

Code 9: An SMS to initiate a search could be as simple as this example provided that the user has set up the required parameters beforehand.

Another solution would be to employ a different mobile communication channel than SMS, a micro-browser-based WAP and i-mode application, for instance. Although this step reduces the available user base (SMS penetration with mobile phone users in GSM networks usually is 100%), the input and interaction possibilities with a richer interface than SMS are appealing.

5.2 The MIX 2.0 Concept

The idea to offer different client interfaces led to the concept of a more generic matchmaking and virtual community application with the working title MIX 2.0. By learning more about the individual users and their interests, behavior and context, an intelligent algorithm could not only recommend users to users but also include other items such as news, events, locations or groups.

[107] MIX 1.0 usability testing results. Internal documents.

A key element should be the explicit verification of matching results, similarly to those I outlined in chapter 3.4.9. The users should be able to express their opinion, to "rate" a recommendation explicitly ("How did you like the concert?") or implicitly (e.g. by choosing "Quit chat with XYZ." after 1 message). This way the system would be able to better match users with users based on the mutual rating results.

Another key element of the MIX 2.0 concept are the so-called "content channels". Unlike the different access channels such as Web, WAP, i-mode, SMS etc., content channels contain groups of users sharing the same interest. This interest can be as simple as subscribing to a "Twin Peaks" news feed (passive channel members) or as complex as discussing, chatting and collaborating with other users in a "Japanese Cooking" channel. Through their active participation, members can leverage the character of a content channel to becoming a virtual community[108].

Messaging within MIX 2.0, i.e. the transport of different types of content and media between channels and users, is a relatively complex field. Because of the multi-channel concept, each message (e.g. a short text, an article, pictures, sounds or videos) can potentially be transcoded and delivered to different end users with different devices using different networks.

Smart Personalization within the MIX 2.0 concept has three dimensions:

- Individual Profile Content Adaptation
- Access Channel and Device Adaptation
- Mobile Marketing

The first dimension includes adaptive filtering of relevant content for the individual user. Of the user's primary interest are messages from and to content channels he has subscribed to. In addition, content from other channels that are of relevance to his context can be recommended by the personalization engine. Thereby the ratings users have given to content items (directly or indirectly) play an important role. According to the rating, context and subscription patterns of individual users, the MIX 2.0 engine is able to match *peer users*, i.e. users whose

[108] Howard Rheingold, creator of the first major internet communities called "The Well", gives in his book *The Virtual Community* (1998) the following definition: "Virtual communities are social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace." <http://www.rheingold.com/vc/book/intro.html> [Accessed: 15 January 2003]

profiles are similar in certain aspects. To match users can also be driven by other users. Terry et al. describe in *Social Net*[109] a way to match to two persons with similar interests (in the case of Social Net based on location and time) and introduce them to each other by a third person, a peer who knows the two persons. Because of a richer knowledge about the individual users the MIX 2.0 engine could work based on additional explicit and implicit data.

The second dimension of Smart Personalization within the MIX 2.0 concept refers to access channel, device and network adaptation. Separating the content of a message from the presentation format on the backend side is a fundamental requirement for enabling transformations between different presentation formats and access channels. An additional task for the intelligent usage of different access channels is to measure the importance of a message for the momentary context of the individual user. While a monthly newsletter does not need to reach its recipient immediately, it is of contextual importance to the user to know that the location of the meeting which starts in 5 minutes has changed. Access channel adaptation in MIX 2.0 includes that in situations like these an adequate (here: more direct but more costly) access channel can be chosen automatically.

Mobile marketing, the third dimension of Smart Personalization in MIX 2.0, is in some ways similar to the individual profile content adaptation. However, the approach is different. While the individual profile content adaptation facilitates the selection of content for a particular user, mobile marketing enables the selection of users and contextual situations for mobile marketing messages. The rich data stored in Smart User Profiles enables a fine-granular definition of target groups, e.g. based on identity profile conditions complemented with conditions regarding content channel subscriptions. A rule set for targeting a potential buyer group for a recently released Audio CD could be:

```
GENDER=FEMALE AND AGE<18 AND AGE>13 AND ACCESS=MMS AND
SUBSCRIPTION='Bluetooth Boys'
```

Code 10: Condition statement for targeting potential CD buyers.

[109] Terry, M., et al. (2002). Social Net: Using Patterns of Physical Proximity Over Time to Infer Shared Interests. *CHI '02 extended abstract on Human factors in computer systems*. Minneapolis, MI, USA: ACM Press. pp. 816-817.

Although this is only a relatively simple static expression, based on the MIX 2.0 Smart User Profiles more sophisticated dynamic segmentations are possible. An extended condition, for instance, could not only cover a group of users based on fixed parameters but include additional users based on similarity and peer matches (e.g. have given high ratings to >2 users of user group XY).

Based on new possibilities like these I have analyzed the MIX 1.0 application again. The following table proposes a list of improvements becoming possible based on Smart User Profiles and learning personalization. A central element of the advanced people matchmaking application outlined below is the mutual rating of matches, which Howard Rheingold[110] would call a "reputation systems".

Feature	Standard Version	Smart Personalization
Search form	Simple form and advanced form with optional fields, this still is "only" a DB search filter, not an adaptive one.	Remembering most recent values + learning forms with pre-selected values (not necessarily latest) . The goal is to show that Smart Personalization returns equal and better results with learning forms than large advanced forms can do
Search algorithm	Random pick from DB matching age and optional fields	Remembering precedent MIXes (no repetitions) + smart pick from DB considering rating results from "similar" users
MIX Rating	Not implemented	Explicit mix rating after mixing, also remembering declined mixes
MIX Analysis	Not implemented	Implicit keyword and topic analysis of MIX chats, soft segmentation into interest groups
Instructions	Option in main menu	Shown during first log-in, tips and tricks during further usage: context-based learning status management
Profile setup	One-time profile setup during registration process	Growing profile principle, device profile
Device Parameters	Not considered	Technical Profile Adaptation. Usage of a low-tech / high-tech device is taken as an additional identity factor.
"Making a match"	Available explicitly by users	available explicitly by users and recommended by the system with personal success report
Profile	Profile with fixed structure	Smart User profile, growing profile

Table 4: Comparison of standard and smart personalized people matchmaking application. Concept evolved from MIX 1.0.

[110] Rheingold, H. (2002). *Smart Mobs – The next social revolution.* Cambridge, MA, USA: Perseus Publishing.

5.3 BAHNMIX Overview

BAHNMIX is the implementation of parts of the MIX 2.0 concept within a specified content domain. Before going into the details I will describe a little bit the background of BAHNMIX: In autumn 2002 the German Railways presented their new ticket pricing model which became effective on December 15th 2002. Even though the pricing system was very intransparent and inconsequent in many areas, one important innovation compared to the older system was that a passenger doing a trip with another passenger on the same route with a shared ticket only needed to pay 50% of the regular price. These going-by-train saver communities could even be formed spontaneously at the ticket office.

The BAHNMIX service offers a platform for matching people who take the same route in order to facilitate these spontaneous group matches. Once users join a travel group (i.e. a specialized MIX 2.0 content channel bound to a specific travel day, arrival and destination stations) they are offered facilities to contact each other (by phone, mobile and anonymous e-mail). The group creator is offered additional privileges to edit travel details and group memberships, for instance.

For creating and joining travel groups, users need to register with BAHNMIX first. The chosen username / password combination serves as a generic login across different access channels: WAP, i-mode and Web. A registration via SMS has not been implemented, however user can utilize the BAHNMIX SMS service without explicit login after having registered their mobile number through one of the other channels[111]. The following diagram shows the BAHNMIX components and their relationship to the MIX 2.0 concept. BAHNMIX in fact uses a basic version of the MIX core consisting of authorization, content channel management, messaging and technical adaptation (“access channels”). Additional BAHNMIX-specific components include a railway station database and a travel price calculator.

[111] SMS as an access channel has been deactivated due to disproportional MT SMS pricing. Offering an SMS premium service (i.e. refinancing via additional MO SMS costs for the user) could be an option in the future though.

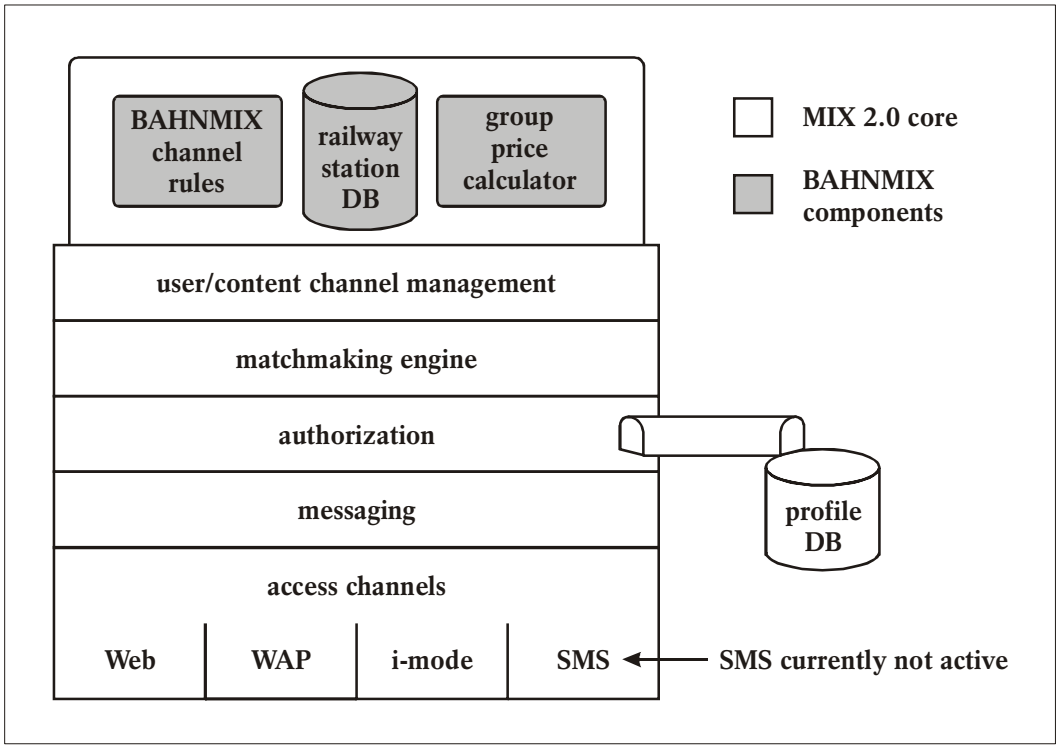


Figure 7: BAHNMIX components extending the MIX 2.0 core system.

5.4 BAHNMIX Browser Type Auto-Detection

One driving idea for BAHNMIX was to offer a simple and easy access to the functionalities, no matter which access channel the user chooses. As a consequence of this guideline the user can access *http://bahnmix.de/* with a web browser, with a WAP browser and even with an i-mode enabled mobile phone. The server automatically identifies the appropriate presentation format (HTML, WML or cHTML) and dynamically redirects the browser accordingly.

The following PHP4 code shows the implementation of some browser detection facilities I created for BAHNMIX, which evaluate the HTTP headers "HTTP_USER_AGENT" and "HTTP_ACCEPT" sent by the user's browser:

```
1   function get_preferredPresentationType() {
2     if
(preg_match("/^portalmmm\/1.0/",$_SERVER["HTTP_USER_AGENT"])) {
3       return "chtml";
4     } else if (
5       (strpos($_SERVER["HTTP_ACCEPT"],"vnd.wap.wml"))
6         &&
7       (
8         (strpos($_SERVER["HTTP_ACCEPT"],"vnd.wap.wml") <
strpos($_SERVER["HTTP_ACCEPT"],"text/html"))
9           ||
10        (strpos($_SERVER["HTTP_ACCEPT"],"text/html")===false)
11      )
12    )
13    {
14      return "wml";
15    } else {
16      return "html";
17    }
18  }
```

Code 11: A function for automatic browser type detection, implemented in PHP4.

One critical requirement for the browser type detection was to include the ability to handle hybrid browsers correctly. The web browser "Opera", for example, can process HTML as well as WML pages, so both MIME types are included in the HTTP request header HTTP_ACCEPT which the BAHNMIX server receives. In this case, the order of the content types matters[112], because a desktop version of the "Opera" browser prefers "text/html" documents to "vnd.wap.wml" documents (Code 8, line 8).

Further adaptive decisions based on the user's browser have not been implemented in BAHNMIX yet. Instead the respective presentation layer implementations follow the lowest common denominator principle as deeper device profile information such as UAProf are not widely available yet. This might change with an introduction of UAProf in the MNO gateways as discussed in chapter 3.2.4, which would enable a comfortable implementation of device specific adaptations.

[112] The W3C has defined the syntax and semantic of all standard HTTP/1.1 header fields as part of the RFC 2616. <http://www.w3.org/Protocols/rfc2616/rfc2616-sec14.html#sec14.1>
Fielding, R., et al. (1999). *Hypertext Transfer Protocol – HTTP/1.1.* RFC 2616. The Internet Society. <http://www.w3.org/Protocols/rfc2616/rfc2616.html> [Accessed: 16 January 2003]

5.5 BAHNMIX Actions and Navigation

One guideline while developing BAHNMIX was that all major functionalities should be available throughout all access channels. The process we followed during the development of BAHNMIX was to start with the Web version which includes all available functionalities. Going from there, we created a ranking for all functionalities (i.e. all actions) including their suitability for each access channel. These results influenced the final order of the navigation items, which was reduced to 1 dimension in each menu on the mobile access channels[113].

Special widgets being used in the web version of BAHNMIX such as drop down menus for selecting the railway stations were found not to be suitable for mobile versions. Although using dropdown menus is possible with WML and cHTML micro-browsers, their utility is limited to a few items. My field tests with actual handsets showed that to offer more than approximately 12 options in a selection list slows the user down significantly, as selecting the last option would require the user to press 13 buttons altogether[114]. Also, the performance of some micro-browsers was very unsatisfying with higher number of items which in some cases even caused software crashes[115]. In addition the possibilities of using long (or even cascaded) selection lists are limited by the maximum document size accepted by the mobile devices. Therefore in BAHNMIX we implemented a multi-level selection framework, splitting up the selection process of railway stations into several steps as shown in figure 8. With a broader availability of

Figure 8: Railway station multi-level selection on Siemens S45.

[113] While on the web the user interfaces mostly utilize a 2D navigational space, interface designs for mobile phones, for instance, usually only use the vertical axis.

[114] 1 click for activating the select menu, 11 clicks to navigate to the last item and 1 click for choosing the menu item.

[115] With a high number of select menu items I was able to put a Nokia 3330 to a standstill.

UAProf data, these selection steps could be adapted to the available display height of the mobile device.

An important part of the BAHNMIX adaptation process to different access channels have been considerations on which actions and their respective navigation triggers should be supported on which access channels. The final actions sets, i.e. prioritized lists of actions and the way how they should be supported, were based on considerations on the action's

- *utility* for the particular access channel,
- on its *navigation and input efforts* required of the user, and
- on its *priority* towards other actions from the user's point of view.

A print banner function for travel group owners, for instance, is an action of the BAHNMIX Web version. By using this function the users are provided with an A4 printout of their group's name, the departure time as well as the travel destination. The utility of this action is clearly limited to Web users with printers.

In respect to the increased input efforts required of the mobile users, the number of fields during the user registration process on mobile devices was reduced to the minimum[116]. Additional parameters such as landline phone number or a memo text field ("100 characters about myself") can be added to the profile in the Web version. While the Web offers various layout possibilities to arrange multiple action items on the user's screen, for the mobile version an elaborate set of prioritized action items was needed. Based on its lower priority for wireless users compared to other actions, the editorial content area "Train Stories" has not been integrated into the mobile versions yet. The prioritization also affected the order of menu items, as shown in figure 9 (About, Search Group, My BAHNMIX, Fun etc.).

Figure 9: BAHNMIX menu on i-mode

[116] Users can create a BAHNMIX account on a mobile or via the Web version. This is a critical requirement as users should be able to utilize all major BAHNMIX features from any access channel.

5.6 BAHNMIX Personalization Opportunities

The personalization techniques demonstrated with BAHNMIX only reflect a small part of what is possible. From the user's perspective, however, the personalization measures implemented already are of high priority and value:

- *Personal group management* provides users with an easy way to check and modify their individual travel groups during multiple application sessions.
- The *cross-channel profiles* enable personalized access to BAHNMIX via different access channels (Web, WAP, i-mode, SMS).
- *Smart Input* such as intelligent form field pre-filling reduces explicit user input. When a user searches for a travel group going from city A to city B on a specific day, and no groups are found, BAHNMIX offers the user the possibility to create a new travel group based on the parameters already entered.
- *Versioning* with BAHNMIX means that the user is offered different versions of the application, each adapted to a corresponding access channel. The integrated browser type auto-detection provides simple access to the suitable version as the user only needs to access <http://bahnmix.de> and is automatically redirected.

Chapter 3 introduced a variety of techniques and factors which an extended release of the BAHNMIX prototype could employ to facilitate an even better user experience. The following describes selected factors and techniques which have the potential to further support the mobile users:

- The lack of geographic details of the railway stations certainly is a problem with the current BAHNMIX prototype. With such kind of data available, fuzzy search results would be possible enabling more intelligent responses. When a user looks for a travel connection from Hamburg central station to Berlin Zoo and only a travel group from Hamburg central station to Berlin East station exists, this group currently cannot be found.
- Implicitly gained location data, where available, could provide a good starting point for an application session. Used as a default value for the departure station or in conjunction with historic behavior data (which stations did the user select in the past?) this implicit factor could significantly save input time.

- Additional adaptation to the individual user's mobile device would enable more optimized user interfaces. Furthermore, richer downloadable clients such as J2ME MIDlets would enable additional interface functionalities and synchronization-based offline usage. By supporting specific device functionalities such as built-in cameras, rich messaging functions and live submissions of BAHNMIX train stories become possible.
- Based on explicit preferences and usage history information, an advanced BAHNMIX application could also provide suggestions and notifications to individual users. Knowledge about the user's travel interests would enable proactive travel recommendations, for instance, which can be enriched with activity recommendations, provided that additional types of content channels (e.g. "citymix", "partymix", "concertmix" etc.) exist. Smarter User Profiles with explicit and implicit ratings would develop BAHNMIX towards a more universal matchmaking application.

6 Summary and Conclusion

The question I asked at the beginning of my thesis on Smart Personalization for Wireless Applications was:

> *"In which ways can wireless applications utilize explicit and implicit user input more intelligently for providing a better user experience?"*

From the starting point of bringing a significantly added value to the end-user, I examined the roles of the three key players in the mobile economic sector: network operators, application providers and device manufacturers. Smart Personalization, requiring an advanced level of collaboration and a commitment to standards from the mobile players, was identified as a key element in influencing the three basic success factors of mobile applications: utility, usability and pricing.

Along the Smart User Profile, which I developed as a framework for building adaptive mobile and multi-channel applications, explicit and implicit input factors were presented and classified. This thesis discussed and illustrated their fields of use with practical examples of different adaptive personalization techniques,

which underlined the mobile users' benefits such as increased efficiency and productivity resulting from improvements including minimized input efforts, optimized interfaces and relevant recommendations.

Furthermore I assessed the importance, opportunities and limitations of relevant mobile technologies and their layers relating to supporting Smart Personalization. The variety of proprietary solutions and the key role of mobile network operators in enabling affordable consumer mobile data services were identified as problematic elements in this context. The MIX prototype implementations and concepts deepened the practical approach of my thesis while demonstrating the difficulties of developing a user-experience-centric multi-channel application from the application provider's perspective. Concerning privacy, legal, and security aspects of adaptive mobile systems I pointed out possible solution corridors.

Smart Personalization is a promising concept that all key players in the mobile market can benefit from. Providing a better user experience is an important element to increase the usage of mobile data services and to motivate device upgrades for utilizing advanced features. It remains to be seen if the alliances currently being formed in the industry can initiate a broader roll-out of user-centered services. Putting comprehensive adaptation to the individual user into practice requires an interdisciplinary understanding and eventually a concerted effort of the whole wireless value chain. The possibilities of location-based services circulating in the public media, the offering of common standardized development tools by Nokia and Sony Ericsson[117] and the increasing availability of smart portals to mobile data users are important steps towards this direction.

[117] Nokia and Sony Ericsson recently announced the availability of common Symbian OS development tools for Q2 2003.

Smart Personalization could finally animate the UMTS buzzword Virtual Home Environment as a publicly available user-centered service foundation spanning different access channels, networks, and content offers. This empty word eventually needs to be filled with available applications powered by machine learning Smart Profiles and inspired by human intelligence and visions:

Smart Personalization enabling Sensible Wireless Services.

7 References

Anderson, C.R. (2002). *A Machine Learning Approach to Web Personalization.* Ph.D. thesis. University of Washington, Department of Computer Science and Engineering. <http://www.the4cs.com/~corin/research/pubs/thesis.pdf> [Accessed: 13 February 2003]

Andersson, C. (2001). *GPRS and 3G Wireless Applications: professional developer's guide.* New York, NY, USA: John Wiley & Sons, Inc.

Billsus, D., et al. (2002). Adaptive interfaces for ubiquitous web access. *Communications of the ACM*, 45 (5), pp. 34-38. New York, NY, USA: ACM Press.

Brücher, H. (2002). *Lokalisierung als Aspekt der Personalisierung mobiler Kommunikationsdienste.* In: ABIS-Workshop 2002: Personalization for the mobile World, Proceedings, pp. 51-58. <http://www.kbs.uni-hannover.de/~henze/lla02/proceedings/abis.pdf> [Accessed: 5 January 2003]

Butz, A. (2002) *Taming the urge to click. Adapting the User Interface of a mobile museum guide.* In: ABIS-Workshop 2002: Personalization for the mobile World, Proceedings, pp. 9-12. <http://www.kbs.uni-hannover.de/~henze/lla02/proceedings/abis.pdf> [Accessed: 5 January 2003]

Capin, T. (2003). *Mobile SVG Profiles: SVG Tiny and SVG Basic.* W3C Recommendation 14 January 2003. <http://www.w3.org/TR/SVGMobile/> [Accessed: 16 January 2003]

Chaos Computer Club (2002). *Security Nightmares III: Worüber wir nächstes Jahr lachen werden.* Presentation at 19th Chaos Communication Congress "Out Of Order". Berlin, Germany. 27-29 December 2002.

Chin, D. N., Porage, A. (2001). Acquiring User Preferences for Product Customization. *User Modeling 2001*, edited by M. Bauer et al., LNAI Vol. 2109, Berlin, Germany: Springer. pp. 95-104.

Cotter, P., Smyth, B. (2000): WAPing the Web: Content Personalisation for WAP-Enabled Devices. *Proceedings of the International Conference on Adaptive Hypermedia and Adaptive Web-based Systems,* (AH2000), Trento, Italy. LNCS 1892, Springer. pp. 98-108.

Duda, S., Schießl, M., and Hess, J. M. (2001). *Mobile Usability Report. Fit Service to User to Device & Reduce to the Max!* Göttingen, Germany: Business-Village.

Durlacher Research Ltd. (1999). *Mobile Commerce Report.* November 1999. <http://www.durlacher.com/downloads/mcomreport.pdf> [Accessed: 15 January 2003]

Durlacher Research Ltd. (2001). *UMTS Report. An Investment Perspective.* March 2001. <http://www.durlacher.com/downloads/umtsreport.pdf> [Accessed: 15 January 2003]

EU (2002). Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications). *Official Journal L 201 , 31/07/2002 P. 0037 – 0047.*

Available via <http://europa.eu.int/comm/internal_market/en/dataprot/law/index.htm> [Accessed: 23 February 2003]

Funk, J.L. (2001). *The Mobile Internet: How Japan dialed up and the West disconnected.* Kobe, Japan: ISI Publications Limited.

Hagen, P. R., Manning, H., and Souza, R. (1999). *The Forrester Report. July 1999. Smart Personalization.* Cambridge, MA, USA: Forrester Research, Inc.

Institute of Electrical and Electronics Engineers (1990). *IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries.* New York, NY.

International Organization for Standardization (1998) *Ergonomic requirements for office work with visual display terminals (VDTs) – Part 11: Guidance on usability. ISO 9241-11.*

Junglas, I., Lehner, F. (2002). *MobiLex – Glossary and Abbreviations in Mobile Business (5th Edition)* [Online]. Available from University of Regensburg, Germany. <http://www-mobile.uni-regensburg.de/freiedokumente/Berichte/MobiLexEnglisch.pdf> [Accessed: 7 January 2003]

Kim, W. (2002). Personalization: Definition, Status, and Challenges Ahead. *Journal of Object Technology*, 1 (1), pp. 29-40. Zurich, Switzerland: ETH Zurich. <http://www.jot.fm/issues/issue_2002_05/column3.pdf>
[Accessed: 6 January 2002]

Knudsen, J. (2001). *Wireless Java™: Developing with Java 2, Micro Edition.* Berkeley, CA, USA: Apress.

Kobsa, A. (2002). Personalized hypermedia and international privacy. *Communications of the ACM*, 45 (5). New York, NY, USA: ACM Press. pp. 64-67.

Kohavi, R. (2000). *KDD Personalization Panel* Presentation. At: Sixth ACM SIGKDD International Conference on Knowledge Discovery & Data Mining, Boston, MA, USA. <http://www.acm.org/sigs/sigkdd/kdd2000/panels/personalization/Kohavi.pdf> [Accessed: 6 January 2003].

Kramer, J., Noronha, S., Vergo, J.: A user-centered design approach to personalization. *Communications of the ACM,* 43 (8). New York, NY, USA: ACM Press, pp. 44-48.

Lightman, A., Rojas, W. (2001). *Brave new unwired world – The Digital Big Bang and the Infinite Internet.* New York, NY, USA: John Wiley & Sons, Inc.

Marchiori, M. (2002). *The Platform for Privacy Preferences 1.0 (P3P1.0) Specification.* W3C Recommendation 16 April 2002. <http://www.w3.org/TR/P3P/> [Accessed: 23 February 2003]

Ng-Kruelle, G., et al. (2002). *Price of Convenience: Dynamics of Adoption Attitudes and Privacy Sensitivity Over Time.* CollECTeR 2002, Melbourne, Australia, December 1-2, 2002 <http://apache.iwi.uni-koblenz.de:8080/iwi/marc/publications/poc-Melbourne.pdf> [Accessed: 15 January 2003].

Nielsen, J. (1998). *Personalization is Over-Rated.* Jakob Nielsen's Alertbox for October 4, 1998. <http://www.useit.com/alertbox/981004.html> [Accessed: 6 January 2003].

Nielsen, J. (2002). *Supporting Multiple-Location Users.* Jakob Nielsen's Alertbox for May 26, 2002. <http://www.useit.com/alertbox/20020526.html> [Accessed: 6 January 2003]

Nösekabel, H. (2001). *Integration von web- und mobilbasierten Diensten* [Online]. Available from University of Regensburg, Germany. <http://www-mobile.uni-regensburg.de/freiedokumente/Berichte/IntegrationWebMobil.pdf> [Accessed: 3 January 2003].

Nokia (2002). *Nokia WAP Phone Characteristics, Version 1.8, 18 Nov 02.* <http://nds1.forum.nokia.com/nds/NDS_TVerification_Interface?path=%2Fdownload%2FNokia%5FWAP%5FPhone%5FCharacteristics%5Fv1%5F8%2Epdf> [Accessed: 3 January 2003]

Open Market, Inc. (2000). *Personalization Strategies: Building the Customer Experience to Meet Business Objectives.* Business White Paper. May 3, 2000. <http://www.ccng.com.au/BWP_Personalization_Strategies2.pdf> [Accessed: 6 January 2003]

Open Mobile Alliance, Ltd. (2002). *User Agent Profile 1.1. Candidate Version 12-December-2002.* OMA-WAP-UAProf-v1_1-20021212-c. <http://www.openmobilealliance.org/docs/OMA-UAProf-v1_1-20021212-C.zip> [Accessed: 20 February 2003]

Osbakk, P., Ryan, N. (2002). Context, CC/PP, and P3P. *UbiComp 2002 Adjunct Proceedings.* Göteborg, Sweden: Viktoria Institute. pp. 9-10. <http://www.cs.ukc.ac.uk/pubs/2002/1553> [Accessed: 23 February 2003]

Perkowitz, M., Etzioni, O. (1997). Adaptive web sites: an AI challenge. *Proc. 15th Intl. Joint Conf. on Art. Int.* <http://www.cs.washington.edu/research/adaptive/papers/ijcai97.pdf> [Accessed: 14 January 2003].

Pine, B. J. II, Gilmore, J. H. (1999). *The Experience Economy*. Boston, MA, USA: Harvard Business School Press.

QUALCOMM (2002). *The Road to Profit is Paved with Data Revenue. QUALCOMM Internet Services White Paper June 2002.* <http://www.qualcomm.com/brew/about/brewwhitepaper.pdf> [Accessed: 3 January 2003].

Ramsay, M., Nielsen, J. (2000) *WAP Usability. Dèjá Vu: 1994 All Over Again.* Report from a Field Study in London, Fall 2000. Fremont, CA, USA: Nielsen Norman Group.

Rheingold, H. (2002). *Smart Mobs – The next social revolution.* Cambridge, MA, USA: Perseus Publishing.

Roth, J. (2002). *Mobile Computing. Grundlagen, Technik, Konzepte.* Heidelberg, Germany: dpunkt.verlag GmbH

Schmidt, A., Gellersen, H.-W. (2001). Nutzung von Kontext in ubiquitären Informationssystemen. (Context-Awareness in Ubiquitous Computing) *Informationstechnik und Technische Informatik 2*, pp. 83-89. <http://www.comp.lancs.ac.uk/~albrecht/pubs/pdf/gellersen_it_ti_02-2001.pdf> [Accessed: 6 January 2003].

von Schoultz, F. / Space Systems Finland (2001). *Indoor Satellite Navigation.* Presentation during the Mobile Navigation session, Interactive Future & Man Conference, Mindtrek 2001, 8 November 2001, Tampere Hall, Tampere, Finland.

Siegle, J. A. (2003). WLAN-Datenfunk als UMTS-Alternative. Generation WiFi. *Internet Professionell.* 3/2003. Munich, Germany: VNU Business Publications Deutschland GmbH. pp. 88-90.

Stolze, M., Ströbel, M. (2001). Utility-based Decision Tree Optimization: A Framework for Adaptive Interviewing. *User Modelling 2001*, edited by M. Bauer et al., LNAI Vol. 2109, Berlin, Germany: Springer. pp. 105-116.

Summers, D. (Ed. Dir.) (1987) *Longman Dictionary of Contemporary English.* Second Edition. London, UK: Longman Group UK Limited.

Terry, M., et al. (2002). Social Net: Using Patterns of Physical Proximity Over Time to Infer Shared Interests. *CHI '02 extended abstract on Human factors in computer systems.* Minneapolis, MI, USA: ACM Press. pp. 816-817.

Thomas, P., Macredie, R. D. (2002). Introduction to The New Usability. *ACM Transactions on Computer-Human Interaction*, 9 (2), June 2002, pp. 69–73.

Wallace, P., et al. (2002). *i-Mode Developer's Guide*. Boston, MA, USA: Addison-Wessley.

Wright, S. (2002). *Personalisation: How a computer can know you better than yourself*. Multimedia Systems Conference 2002, University Of Southampton, Southampton, Hampshire, UK. <http://mms.ecs.soton.ac.uk/papers/14.pdf> [Accessed: 13 February 2003]

Fielding, R., et al. (1999). *Hypertext Transfer Protocol – HTTP/1.1*. RFC 2616. The Internet Society. June 1999. <http://www.w3.org/Protocols/rfc2616/rfc2616.html> [Accessed: 16 January 2003]

WAP Forum, Ltd. (2001a) *WAP Push Architectural Overview*. Version 03-Jul-2001. <http://www1.wapforum.org/tech/documents/WAP-250-PushArchOverview-20010703-a.pdf> [Accessed: 13 February 2003]

WAP Forum, Ltd. (2001b) *XHTML Mobile Profile*. Version 29-Oct-2001. <http://www1.wapforum.org/tech/documents/WAP-277-XHTMLMP-20011029-a.pdf> [Accessed: 13 February 2003]

8 Appendix

8.1 Experts Survey

During my thesis I have been interviewing some experts on their opinion about 10 interesting questions connected to Smart Personalization for Wireless Applications. The following compilation shows their combined answers made anonymous:

1. Customization, Personalization, Prioritization - how would you describe these terms briefly and how would you separate them from each other?

- Customization: active (=not automatic) changing of the interface by the user (or someone else for a specific). Personalization: active customization or passive changing of the interface by a program based on a generated or entered profile. Prioritization: Priority = importance for a specific person. Mapping the abstract "importance" to a discrete value.
- Customization: adapt an application according to preferences. not necessarily dependent on user, but also on location, locale, etc.
- Customization: Targeted personalization by means of explicit action of the user, provider or manufacturer (refers more to the possibility to adapt)
- Personalization goes one step further as it brings in the very personal, unique identity which ultimately could mean that there is only 1 personalized application matching the personal profile of a unique user. When it comes to computer systems and user interfaces I believe the term personalization is more common.
- Personalization: generic term for all techniques leading to the individualization of a product or service (thereby including adaptivity and possibility to adapt)
- Personalization: customize according to (personal) user needs and requirements (subset of customization)
- Prioritization is not a very strong concept, as it can happen anywhere and anytime when the user has got more than one choice and does something first (in terms of sequential/temporal order) or never.
- Prioritization: grade applications or menu items according to some metric - the priority.

2. What does "Wireless Usability" mean to you? Is there any difference to Web usability?

- It should work while driving a car
- No noticeable loading time
- Big Text vs. lot of information and text, colorful, big buttons
- Blinking can be useful vs. No blink
- Usability means that the user is able to use an application without reading a manual. In a mobile usage situation there is never manual at hand and probably no online help either. Good usability does not need a manual. So in the wireless situation the user has a got a small device with a little screen and should be offered the functions that are most common and logic in a certain application with a certain menu structure. So, basically, mobile usability is even more important. So crazy people write whole reports about it and at the same time, there are very few usability standards in a young medium which necessitates smart developers paying very much attention to the users' feedback from the first day onwards.
- Wireless usability is not so much the difference between wireless vs. wireline but more dependent on the terminals used, i.e. PDA, mobile phone. As these also use the web it's more terminal, phone, PDA vs. PC than wireless vs. web.
- From my point of view wireless usability goes far beyond web usability. The basic principles for good web design (download speed, readability, necessity to scroll) are increasingly valid for mobile end-devices (small displays, thin bandwidth, only basic input capabilities etc.).
- In addition, other aspects specific to the user's mobile context need to be considered: Where is the user? (e.g. voice interface inadequate if sitting in a concert) What is the user doing? (e.g. Is the user still able to use a mobile navigation tool when running through the railway station?)

3. Which adaptive mobile applications do you know? How well is personalization tackled respectively?

- :-(
- I basically don't know any good mobile application that is personalized to me. I do not use any personalized application except for my telephone book in my mobile phone into which I save numbers of people I want to call to find them easily again. Before looking into the benefits of using an

application in a personalized way I wonder whether I really need it urgently and whether I am willing to pay for the costly traffic mobile network operators charge me for.

- Almost none. The only type of personalization is automatic login and to some extent location recognition.
- Email- and News service Adaptiveinfo.com, which calculates the relevance of Emails and News articles based on user feedback and other factors.

4. With which types of mobile applications / with which content domains do you see the biggest potential of adaptive personalization?

- Email (only "important" mail is shown)
- Calendar (adaptive signaling, birthday reminder)
- Smart communication aware of the users' presence and channel preferences. Agents making appointments with known or unknown people in the background for business or private get-togethers. A personal shopping agent is the ultimate goal but an agent helping me to manage the communication needs and the time budget can become very powerful - of course, only if you can personalize it and - control it!
- Location Based Services
- Permission-based Marketing
- Navigation
- Leisure, events, mobile virtual communities
- Payment

5. From your point of view, would a unique user identifier across multiple MNOs be desirable (~MS Passport for mobile)? If yes: In which way should this identification be implemented?

- NO! Every "good" implementation would bring many legal problems and gives to much power to a single entity.
- A mobile user wants to use any service independent of their mobile network operator. Because users don't trust the editorial and marketing mix served by the employees of a quasi-monopolist. A new service needs some kind of "trust stamp" even if it is unofficial. A user does not want to be spammed by sites that he surfs once or more often. A mobile MS passport system has to take this into account. The main question is what you need the identification for. Do you really transact with your mobile in the fu-

ture? I would think about the applications that need unique user to be easily identified and authenticated when revisiting the service.

- Not really needed as very few people have more than one provider. However, a unique identifier across applications within one MNO would be nice. This should probably be based on the MSISDN + SIM-based authentication.
- Absolutely – with your mobile phone number which you even keep when switching your MNO (in Germany). The critical factor will be the privacy control on your personal data: Who is provided with what data? The idea of an agent (see: P3P) automatically managing my profile and incoming access requests sound interesting.

6. Which importance do you attach to adaptivity towards different devices? Which are the minimum efforts a mobile application provider should make or is one-version-fits-all-devices enough?

- One-version-fits-all would be best and should be reached in some years.
- The user demands a perfect service and does not care what needs to be done in the background to produce it on-the-fly. It is wishful thinking that manufacturers adopt the magic single device profile standard, so the intelligence needs to be in the software on the server serving the content. Creativity of manufacturers only enhances the problem and does not reduce it. Whatever helps to aggregate device problems is welcome.
- At least have automatic recognition of phone devices and adapt applications to display capabilities thereof. Ideally also cross-channel, i.e. PDA, PC, Smartphone etc.

7. Which areas of adaptive personalization should a mobile application service provider focus on primarily? (Give an ordered list if you like.)

- Prioritize the basic needs: Serve content well customized to a specific device the user requests the service with. When you have managed this problem think about what different user groups you have and try to segment a little.
- Making a 100% personal application you can do if you have got lots of time and a proof that you can extract more money from your users or advertisers if you provide a super personal service celebrating the individuality of each representative of mankind.

- (1) user-centric including history etc., (2) terminal centric: adapt application to display capabilities, (3) location-based
- Location-based information services
- Services managing the user's personal schedule and able to proactively act on problems and changes.

8. What are the reasons why only so few mobile application providers have implemented personalization today? (Too busy with getting basic functionality running? Lack of inexpensive and easy to implement frameworks? Simply unfamiliar with adaptive personalization? ...)

- They are still in first grade and always forget to do the homework. What is a teacher supposed to do with such a bunch of students?
- Terminals too fragmented and too little technical support from carriers. also "it's not mine, don't support it" attitude still widespread.
- Too busy with getting basic functionality running
- Simply unfamiliar with adaptive personalization, i.e. no ideas – most think that spamming people walking in the pedestrian's zone with mobile discount coupons is "leading edge technology" :-(

9. How do users react to adaptive systems? What are your experiences (positive/negative examples)?

- It is all about transparency: If the user does not understand why an application does behave and adapt in a specific way the level of trust in their own ability to control this piece of technology decreases rapidly to a point of surrender. Quite dangerous this point, indeed. My personal experience with smart apps is too small to comment better.
- positive: Amazon, negative: targeted pop-up banners (no examples for mobile apps).
- Highly depends on the implementation, can confuse users (e.g. Windows adaptive menus with modifying and hiding menu items)
- The users want to see results early. That means: no long training periods and only then adapting the system's behavior.
- Users mistrust adaptive systems first of all. Because of that it is important, to choose a safe route at the beginning and expect not too much of the user. By-and-by "mutual trust" needs to be achieved.

- The user's possibility to inspect and modify one's profile is seen as an important point by many experts. From my experience I can tell that many users of adaptive systems have taken a look into their profile at the beginning, but later on didn't care about this possibility anymore. Nevertheless simply having the possibility to control and correct the system is recognized to be very important.

10. Let's look 5 years ahead: What would you like your mobile device and mobile app to do for you?

- Track my girlfriend ,)
- Play music
- Play video
- Let me read email
- Run Linux ;-)
- Run Java
- Display XML/XSLT/FO Files
- IPv6
- Put me in touch with a nice lady for a video chat after our agents have matched the profiles of us and our friends to reduce the level of disappointment (too ugly, unintelligent, boring or slow)
- Guide me through the city, manage my personal finance, keep me updated on the whereabouts of my friends and colleagues, act as my wallet and keys etc. - and of course do all of that for free...
- Cashless, secure payments
- Context-sensitive information about relevant events (news, email, burglary in my house, ...)
- Applications of telemedicine
- Management and optimization of my (professional) schedule: Recognize beforehand when I won't catch my train, automatically change a reservation and arrange a hotel, notify waiting business partners, ...

8.2 Glossary

3G	Third-generation wireless
API	Application Programming Interface
ARPU	Average Revenue Per User
Bluetooth	Standard for Radio transmission Peer 2 Peer networks
BREW	Binary Runtime Environment for Wireless (by QUALCOMM)
CDLC	Connected Device Limited Configuration for J2ME
cHTML	Compact HyperText Markup Language (used with i-mode)
CSD	Circuit Switched Data
DB	Database
DVB-T	The terrestrial version of the Digital Video Broadcasting standard
GPRS	General Packet Radio Service
GPS	Global Position System
GSM	Global System for Mobile Communications
HSCSD	High Speed Circuit Switched Data
HTTP	HyperText Transport Protocol
IEEE	Institute of Electrical and Electronics Engineers, Inc.
i-mode	Mobile data service, billing and revenue sharing model introduced by NTT DoCoMo. Uses cHTML as a presentation language
IrDA	InfraRed Data Association
IrLMP	InfraRed Link Management Protocol
ISO	International Organization for Standardization
ITU	International Telecommunication Union
Java	Java is an object-oriented Programming Language
J2ME	Java 2 Micro Edition
LBS	Location-Based Services
MIDlet	An application conform to MIDP
MIDP	Mobile Information Device Profile, building on CDLC
MMS	Multimedia Messaging Service
MNO	Mobile Network Operator
OTA	Over the air, e.g. OTA provisioning
Palm OS	A PDA computer operating system
PartnerML	proprietary XML standard for Vodafone Live! content providers
PDA	Personal Digital Assistant

Perl	Practical Extraction and Report Language
PHP	PHP Hypertext Processor
QoS	Quality of Service
RDF	Resource description framework
Series 60	A set of APIs and extensions for Symbian OS 6.1
SMS	Short Message Service
SSL	Secure Socket Layer
Symbian OS	A Smartphone operating system
TLS	Transport Layer Security
UMTS	Universal Mobile Telecommunication System
VHE	Virtual Home Environment
WAP	Wireless Application Protocol
WLAN	Wireless Local Area Network
WiFi	Wireless Fidelity – popular term for WLAN
WML	Wireless Markup Language
WMLScript	Scripting Language similar to JavaScript, part of WAP
WTLS	Wireless Transport Layer Security
XHTML	Extensible HyperText Markup Language
XML	Extensible Markup Language

8.3 Eidesstattliche Erklärung

Ich erkläre hiermit an Eides statt, dass ich die vorliegende Diplomarbeit selbständig und ohne unzulässige fremde Hilfe angefertigt habe. Alle verwendeten Quellen und Hilfsmittel sind angegeben.

Furtwangen, den 28.2.2003

Matthias Hellmund