EFFICIENT INFORMATION RETRIEVAL FROM HANDHELD TERMINALS WITH WIRELESS DIGITAL PHONE INTERFACE
Personalized information access on mobile phones and PDAs

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Abstract: Currently, the success of data services used through digital mobile phone networks is very limited. Different reasons can be identified for this: At first, the costs for data connections through these wireless networks are extremely high. Secondly, the user handling of the physically constrained handheld terminals appears as very uncomfortable. Here, a concept for customer-centred information services is proposed, which meets the limited capabilities of the terminal devices. An adequate UI is presumed to make the use of data services on mobile digital phones as also on PDAs more convenient. Furthermore, the information access speed is increased and the costs for the information retrieval are reduced by the described concept.

1 INTRODUCTION

Digital wireless telephony provides different methods for data communication. A very simple service is the exchange of short messages (SMS) as connection-less datagrams, which carry as payload a small text-based message. It is also possible to run continuous data links equivalent to a modem connection for analogue landline phone networks. For the operation of higher-level protocols, like WAP browsing, there exist today different communication methods, but the detail method is of minor interest, when using this kind of service.

What appears more important and with direct consequence to the user is how these data services are handled, and which costs have to be paid for their use. To the costs, it can be stated that these are very high in comparison to landline telephony networks. On the other hand, for an access to the worldwide Internet, private users have today mainly the choice between landline and wireless telephony networks. Most telephony companies operate both kind of networks, and the tariffs of the different companies are always in a very similar range, which ends up with the actual situation that data transfer costs through wireless links are much much more expensive than through landline networks.

Considering next, the usability of data services on handheld devices shows that the user has to deal with some inconvenient limitations. Due to their nature, the small devices are only equipped with numeric keypads and small display screens. This, of course, is required for keeping the units small, lightweight, and preserving a long operation time under battery supply. However, these inherent limitations are often disregarded by the UI structure of the terminal software: Tree-based UI systems requiring in many cases lengthy input strings are more than inappropriate for small devices. WAP browsing is one typical negative example for this: The system concept obviously was inherited from WEB browsing on desktop computers with full keyboards and huge screens, and by that, it appears not adequate for the small devices (Johnson, 1998).

In a discussion of wireless data services, WLAN as relatively new technology (IEEE standard 802.11, 1999) has to be regarded as well. For using WLAN, either a Laptop computer or at least a PDA is required, which has the proper network interface hardware. Although WLAN has established an important role in public life (Riezenman, 2002), and is available in many public places – sometimes even as cost-free service - it cannot fully substitute digital links through wireless phone networks, because in the WLAN system no roaming is foreseen. That means if the user of the wireless data link starts moving, the WLAN service is quickly lost. New WLAN standards and concepts aim to implement longer ranges and roaming features (Zahariadis, et al., 2004), but in the end, much more complicate hardware equipment is required than for the access

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to digital phone networks. Hence, it does not make sense to discuss WLAN at the moment as communication base for highly convenient wireless information services, which should be seamlessly accessible from any place.

Small mobile terminals like digital handheld phones or PDAs with phone interface are equipped with optimised properties in terms of movability and operation stand-by time. For instance, a typical phone can be linked to the phone network for up to two weeks without recharging its battery, and it weights only around 100 grams. On the other hand, the constraints of the user interface demand a system concept, which minimizes any required user input. This can be met by the concept of customer-centred service reported here.

In contradiction to general information services, like e.g. WAP page sets, a service has to be operated on the Internet side, which collects the information particularly desired by a certain customer. The mobile device shall play in this system only the role, which was the original intention for these units: It shall act as presentation terminal without much intelligence. Like described with the examples in the following sections there arise a series of advantages from this concept: Optimised UI handling on the terminal, reduction of data transfer volume, and by that a cost reduction of the information retrieval and an increase in information access speed.

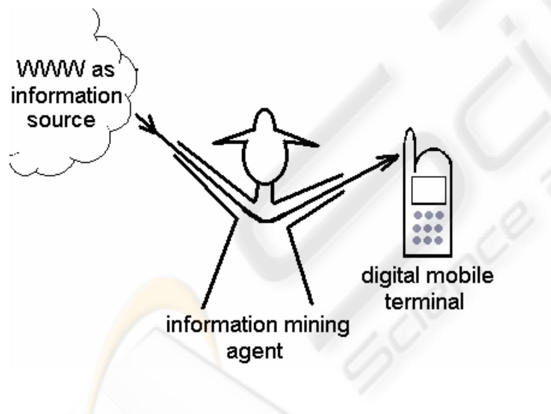

Figure 1: On demand, a specific service agent sources the desired information from the Internet and transmits the result to the mobile terminal.

2 SOLUTION APPROACH

Due to the different inherent limitations of wireless digital terminals, the following properties have to be optimised for an information retrieval operated on those units:

- Minimization of user input actions
- Minimization of data transfer in terms of volume and duration of the connection
- Minimization of computational efforts on the terminal

A system concept, which fulfils these issues, can be built up on a central service agent, which handles and prepares the desired information contents on the Internet side. In this concept, the mobile terminal has to execute simple-styled display software (Fig. 1).

2.1 Optimisation of the UI

A primary goal of the UI design is to minimize the required user actions for obtaining information contents on the mobile terminal. This can be achieved with two closely linked applications: One application is used for entering a configuration set for information queries. A second application is used for executing the information retrieval. Technically such a system can be implemented with wireless JAVA (≡ J2ME ≡ JAVA micro edition) (Piroumian, 2002). Main applications in J2ME are called MIDlets, and MIDlets can be grouped in suites for sharing a non-volatile data area – the so-called record management store. Hence, this technology is well suited for implementing exactly the proposed structure for the terminal software (Fig. 2).

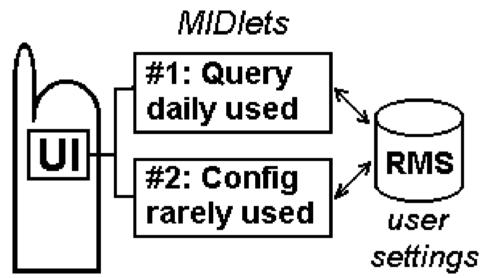

Figure 2: The terminal software can be constructed as MIDlet suite containing two independent applications: One for the information query, and another for configuring the querying parameters.

The handling properties of the two application parts are heavily asymmetric. While the actions for running the querying part are minimized, the configuration part may be as uncomfortable as used from other mobile phone software tools. For configuring the runtime behaviour, specific data has to be entered through the configuration tool. For instance,

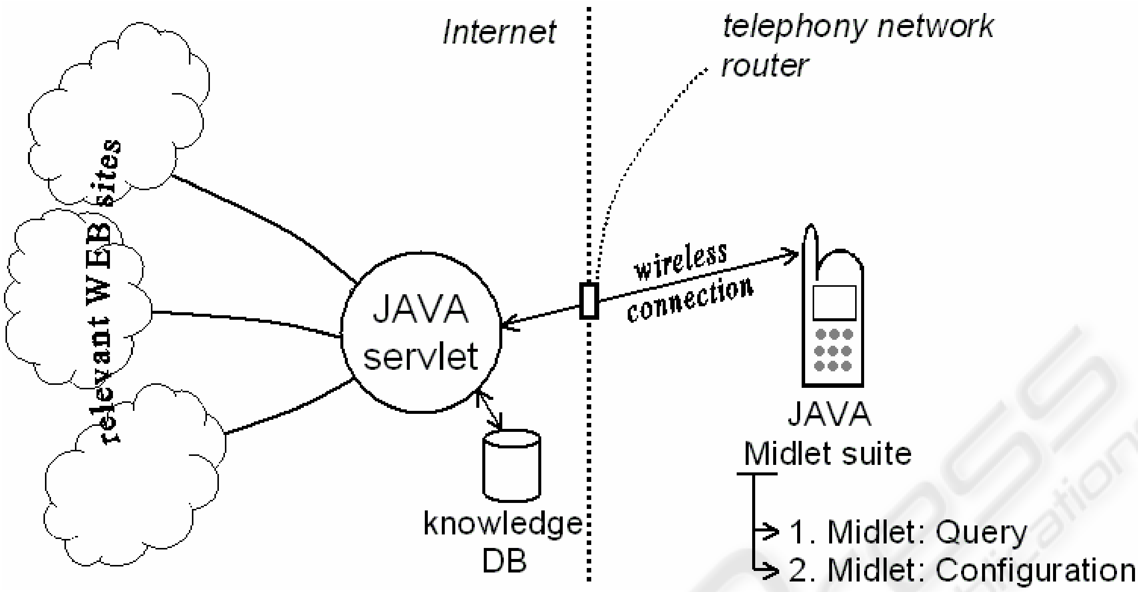

Figure 3: An intermediate information-mining agent, which can be realized as JAVA Servlet, sources the desired content from appropriate WEB sites on the Internet, and transfers the result to the handheld display terminal.

if this system should be used for accessing e-mails, all the relevant account information would have to be entered; in this sample it would be an account login and password, and a mail server address. Entering this will be very inconvenient, but the advantage is that it will be performed very seldom. On base of this input, the execution of the information queries will be very efficient and easy to use, which consequences that the user will see no barriers to use the service very often.

2.2 The intermediate information service agent

Next, the question shall be answered, how the querying tool obtains the desired information content. A data-mining agent residing on the Internet can be employed for achieving this goal (Fig. 3).

JAVA offers again a convenient technical implementation possibility with so-called Servlets (Hall, and Parr, 2001). These are small software tools, which can automatically be launched by queries to appropriately configured WEB servers. Similar technical possibilities exist alternatively with scripting programming languages like Perl or PHP, but here the question is more important, which tasks the mining agent has to fulfil.

On demand, the agent has to collect the desired information contents from the open Internet, in most cases this can come from various WEB sources. Often the same information is available on different WEB sites, which are completely independent of each other. If multi-sourcing of information is available, the central service agent can – in addition to the plain data sourcing – qualify the accuracy of the information. This quality of information – or with recent terms this would be called more QoS = quality of (information) service – can be communicated to the user. Especially the latter feature of the mining agent shows that the concept is considerably more elaborated than the idea for wrapper or mediators, which were reported earlier (Mahmoud, 2002; Wang, 2003).

Hence, the central service agent will collect the desired contents, and measure its precision, but it will also finally prepare the obtained data for a highly efficient wireless transfer. In contradiction to the coding of WEB sites with (D)HTML (Zakour, et al., 1997), or XML (Bradley, 1998), which do not regard any size limits for content pages, the wireless link should be operated with a minimal size for the transferred information. This will help to speed up the wireless transfer, and by that, it will help to minimize the network usage cost. This communication structure respects that the bottleneck in such system clearly is the wireless telephony link in terms of transfer speed and tariffs.

Figure 4: Sample of a traffic information page of an Internet WEB site of a public radio station: This source is used by the mining agent to collect the desired content - in the sample here the highway “A8” was defined as querying target. After launching the display MIDlet on the wireless terminal, the agent is activated by a HTTP query (containing as parameter the selected road), and the returned result is displayed. After this, the user can scroll through the response.

2.3 Traffic information channel as practical application sample

For showing the practical benefit of the described concept, the following discussion should refer to an information system, which is being implemented by students of our University as exercise project. The idea of the service is to provide a personalized access to car traffic information. Most radio stations operate today WEB sites (Fig. 4). These radio stations present in their on-air program information about traffic jams, accidents, and recommended alternative driving routes. Usually, the same information is also accessible through the WEB sites, and can be used for a service according to the before described concept.

At the moment, two student teams are working in our University independently on the realization of systems, which retrieve traffic information from the WEB by a central agent, and which allow a display of this information through a specially developed software on mobile (phone) terminals. In both traffic information systems, the terminal software is implemented in JAVA according to the concept in Fig. 2. In the configuration tool the user has to enter the highway or road name, for which traffic messages shall be retrieved. For regional traffic information the QoS measure is being realized in these implementations by sourcing WEB sites of different independent radio stations, which provide this kind of messages about the same region.

A traffic query can be initiated on the mobile terminal with a minimum of user actions (Fig. 4): The query application has to be selected from the phone menu, and then it has to be launched. After this, everything happens automatically: The querying MIDlet reads the preferences from the configuration data, and activates the agent on the Internet side by a parameterised HTTP access (Knudsen, 2002). For executing the central service agent, which is realized as JAVA Servlet, a dedicate WEB server host was installed at our University with the required features. For this server a very short hostname was chosen, and a shortcut to the WEB directory link was configured, so that the services can be called by a HTTP access with a very short target address.

2.4 Realization of other information systems

In the frame of an elaborated programming lecture at our University the topic of J2ME was introduced (Weghorn, 2003). The students could select as assessment work one implementation project out of a defined list of information systems, which are constructed like the one, which is described in detail above. In total twenty teams of two students were funded, and they were and they still are doing a development of information systems on car traffic channels, public transportation, railway connections, and skiing arenas in the Alps.

The student teams are implementing both parts of the information system – the terminal software, and the central service agent. Of course, since this work is part of a learning lesson, the results are not all prefect. Only a few teams came close to the above described optimal system concept. But in the end, in sum a series of information systems are implemented, which can be useful for various exemplary situations.

3 SIMULATION AND REAL WORLD DEVICES

Due to budget limitations at our University, wireless tools for digital phone networks cannot broadly be developed and tested in the target environment. This is also not really required, because simulation environments are widely available for developing and testing in particular J2ME applications. One simulator is supplied within the wireless toolkit from the company SUN Microsystems (accessible from http://java.sun.org/j2me). If the developer aims for a specific target device, all the big phone manufacturers (Motorola, Nokia, Siemens, …) operate WEB sites for developers, where simulators of various JAVA-enabled phone models can be obtained. In our practical experiments, simulation was used to develop and officially assess the many different projects.

Some of the student teams ambitiously wanted to run their tools on real physical devices and telephony networks. Hence, a few of the projects were demonstrated in the real world. During this, it turned out that the implementation of the J2ME idea is not yet sufficiently elaborated on many devices. Even when using the high-level UI only, the developer has to take care of behaviours of mobile phone devices, which were not in accordance to the original J2ME specifications. Workarounds can be used in these cases, but the problem that is shown by this experience is that at the moment it is not possible to rely on a software, which is constructed in full accordance to the J2ME specifications.

Without pointing to any specific vendor – because most phone vendors have similar styled problems – it has to be remarked that the level of the average phone J2ME has not yet reached a professional state. Furthermore, security restrictions prevent that the UI can be truly minimized, because in many phones the user has to manually select the applied network data link, when the JAVA MIDlet starts an HTTP query. By this kind of mechanism, for which there exist certainly good security arguments, the terminal software cannot be optimised to the full degree.

Another issue is the network access speed on real world devices. The query for the traffic channel information takes on a real wireless phone network approximately 15 seconds, while in the simulation environment the query is processed in around a second. Although this appears on a first glance as a back draw, the use of the described service will be much more efficient than the possible alternatives. Considering the practical example that one has to decide after breakfast which way to drive to the working office, the information collection through the proposed system would require at maximum half a minute, and around three keypad presses (□ user input actions). The alternative would be to use a voice announcement service, which would take at least the same time, and the user has to select his particular information out of this generalised service, or to use WEB browsing on a desktop computer. Especially the latter method would consume several minutes for obtaining the desired decision input (booting of the computer, connecting to the Internet, browsing action, shutting computer down).

4 FUTURE TECHNOLOGIES

Starting the discussion of wireless data accesses with the relatively simple SMS communication system (section 1) probably does not appear as appropriate. Nevertheless, due to recent developments in J2ME technology, this ancient communication method will come into question for the described information systems. One important feature of the most recent specification of wireless JAVA (it is named MIDP version 2.0) is the capability of PUSH mechanisms (Fig. 5).

With the PUSH system, J2ME tools can be activated automatically (Ortiz, 2003). For this, the MIDlets have to register for the required service. In the particular application here, the terminal display

MIDlet can be activated by a SMS, which is sent from the Internet agent of the information system to the handheld device. Depending on the size of the transferred content, the invoking SMS can already carry the required information package, and no additional networking is required by the display MIDlet for assembling its output.

This kind of communication can be used for, e.g., the traffic information channel, because the response to the mobile terminal typically is very small: When the customer is on the way driving to the working office or back home, a fully automated system may be even more helpful than the above described one, because the user will not be able to actively handle information queries. With the PUSH system the user can be informed automatically about a recommend change of the driving route through the combination of an information agent and the appropriate terminal software. This variant would truly reach the absolute minimum for required user handling actions on the terminal.

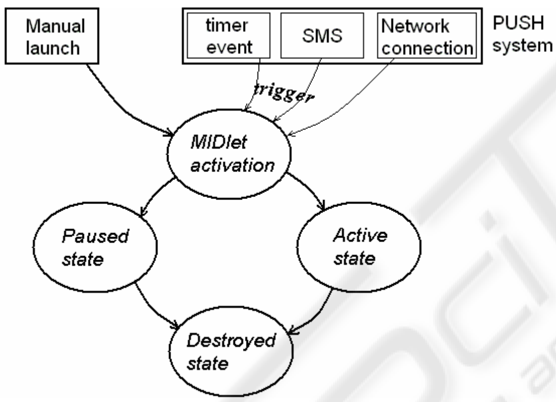

Figure 5: The life cycle of a MIDlet of the most recent J2ME generation provides with the PUSH system additional possibilities for activation.

5 CONCLUSIONS

In contradiction to generalised information services, like e.g. WAP browsing, the proposed customer-centred concept can make information access from wireless handheld terminals very comfortable and convenient. With this approach, the UI as also the locally required computational effort can be minimized. A lowering of costs and an increase of access speed is presumed to make data services used through wireless digital phone networks more attractive for the average, non-technical customer. How this can be achieved, is shown with the sample implementation of a customized traffic channel service.

The introduction of an intermediate information agent allows also accounting for a topic, which is at the moment widely disregarded: Most users are not aware of the quality of all the huge amounts of information, which can be easily retrieved by WEB browsing. The agent system allows measuring a QoS value, which is also being implemented as example in the developed traffic channel system.

As seen from the application of the proposed tools in real world networks with real phones, there is still space for optimisation. A further improvement of access speed and UI comfort can only be obtained, when the terminal developers, in particular the phone manufacturers, improve the device software. On the other hand, from the given examples it can also be derived clearly that the handling of the proposed service system is much more efficient than traditional methods through voice announcement services or WEB services accessed from desktop (or laptop) computer systems.

Further concept developments and improvements are planned with investigations on base of the newly available PUSH technologies. The goal is to further simplify the UI handling, increase the information retrieval speed, and diminish the information access costs.

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