Towards the Design of a WAP-based Environmental Information Service

Joerg WESTBOMKE
University of Applied Sciences Stuttgart
D-70191 Stuttgart, Germany

Michael HAASE
ISB AG
D-70178 Stuttgart, Germany

Renate EBEL
State Institute for Environmental Protection Baden-Wuerttemberg
D-76185 Karlsruhe, Germany

Dieter LEHNE
State Office for Environment and Geology Hesse
D-65022 Wiesbaden, Germany

ABSTRACT

Cellular phones have almost replaced conventional telephones for public use in Western European countries. Modern WAP enhanced phones or smart phones offer mobile access to the internet, anytime and anyplace. This technique therefore appears to be very attractive for transferring up-to-date information about the environmental situation to the public, i.e. air and water quality measurements or weather conditions as well as forecasted values of these processes. The Wireless Application Protocol (WAP) is the key technology in this respect. According to the upcoming importance of mobile internet access the WAP technology has great potentials to play an important role in the design of modern information services which are user centered. Because of upcoming environmental laws in Europe the citizen will gain the right to access the environmental information collected and stored by the public authorities. But due to size and resolution of the displays used in the actual versions of the cellular phones it is not sufficient to transfer the concepts and architectures known from internet information systems to WAP-based systems. It is rather necessary to develop special concepts for the design of WAP-based services, with a special focus on the appropriate structuring and presentation of environmental data. This paper gives an overview of the main problems WAP system designer had actually to deal with and shows concepts how to solve them. At the end of the paper we present two mobile environmental information services, which were realized on the basis of the presented concepts.

Keywords: WAP, Environmental Information Service, Mobile Internet Access and Location Based Services.

1. THE WAP TECHNOLOGY

WAP (Wireless Application Protocol) is a technology that forms a bridge between a wireless GSM (Global System for Mobile Communication) based mobile communication network and the internet. It allows a cellular phone to connect to a host computer on the internet and to transfer data with him, roughly the same way as an internet browser does when he requests a HTML page. The main difference between the WAP phone and the internet browser is that the microbrowser on the cellular phone requests pages coded in WML (Wireless Markup Language) and that the data has to be transferred to the microbrowser via a wireless network, which is not IP-based like the internet is. The conversion from the IP-based internet to the WAP-based wireless network is done by a WAP gateway, which is normally hosted by the wireless network provider. The following figure 1 shows the general system architecture of a WAP based information system.

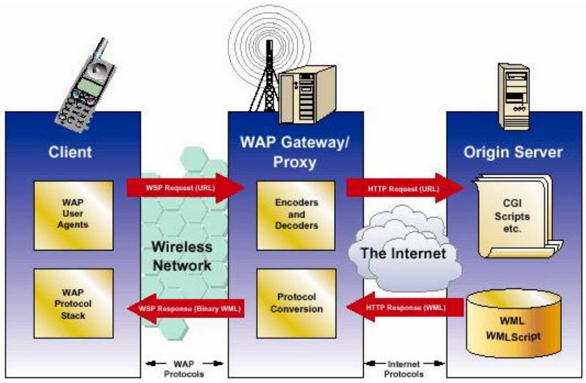

Fig. 1: General system architecture of a WAP based system (Source: WAP Forum)

The performance of the mobile internet access depends on the standard used for the data exchange within the mobile network. The basic GSM standard offers a data exchange rate of 9.6 kbit/s. Actual cellular phones support HSCSD (High Speed Circuit Switched Data) or GPRS (General Packet Radio Service). The HSCSD technology increases the useable data transfer rates by channel bundling up to 76.8 kbit/s, which is comparable to the performance of an ISDN internet connection. Cellular phones which support GPRS, transfer data with up to 171.2 kbit/s which is not only much faster than HSCSD it also realizes the always-on functionality. This means that the mobile device can always be connected to the internet without any charge. Only when data is send or received the user will be charged for it. As a consequence the charge the user has to pay for the internet access is based on the volume of transferred data and not on the time the user spends in the internet. The latest generation of cellular phones supports the new UMTS standard which allows data exchange rates with up to 2 mbits/s. But these devices are currently not widespread and UTMS networks are only available in very few areas.

From the technical point of view the WAP technology fulfills all requirements to realize a mobile internet access. But the mobile internet access actually realized by cellular phones is not really comparable to the internet access gained on PCs. The main reason for that is not the wireless networking capabilities but the restricted display capabilities of presently available cellular phones. But there is actual no real alternative to WAP phones when realizing an area-wide mobile internet access, because cellular phones are the only available mobile internet technology which can be used nearly everywhere in the West European Countries. So for example 98% of the area of Germany is covered by GSM networks.

2. CONCEPT OF A WAP-BASED ENVIRONMENTAL INFORMATION SERVICE

Due to its enormous spread among the population cellular WAP phones are very interesting opportunities for the public authorities to inform the public on environmental issues. Mobile devices can be used anytime anywhere, therefore they are especially suitable for up-to-date information about the environmental situation, like measurements on local air or water conditions or actual weather conditions and forecasts. Especially up-to-date information about gauge levels of rivers and flood prediction in case of a flood is currently a topic of high importance for the environmental authorities in Europe.

So, WAP services are a good completion for the existing media channels like internet, videotext or print media and will help the public authorities to fulfill their duties to give the public access to environmental information. But to use the full potential of WAP services it is necessary to take the actual limitations of the microbrowser and their display capabilities into account. This means that adequate concepts for the information presentation and corresponding navigation strategies have to be developed and realized.

Data Visualization

The mediation of complex environmental data, like air pollutant concentration, needs a user centered visualization concept, which takes the special demands and needs of the user into account. For the realization of a public electronic information service it is of high importance to replace little expressive numerical data and extensive numeric tables by more simple visualization forms respectively to judge them or to set them into relation to corresponding guide values. Another requirement is the filtering of the for the actual situation relevant data, to avoid optical overload of the display and to reduce the amount of data to be transmitted. The chosen visualization concept should enable the user to efficiently find and grasp the requested data. Only that way a WAP-based environmental information service is advantageous applicable. Over and above that environmental measurements have a spatial reference, which should be expressed by topographic diagrams. Often environmental data also refer to a temporal reference, which makes it necessary to visualize time series and measurement charts.

The properties of the displays limit the visualization possibilities that can be realized in a WAP service. Normally these monochrome displays have a display size of 100×60 pixels, which is suitable for displaying four or five text lines with up to 26 characters. Although more and more new models appear on the market which offer a color display with larger dimensions the before mentioned dimensions can be considered as standard.

Beside the limited size of the display WML did not offer enough expressive power to define the layout of a page exactly. Therefore it is necessary for the design of a WML page to reduce the information offer to a WAP compliant measure. To achieve this, the necessary data should be divided into as less as possible pages to simplify the user prompt and to avoid a frequent loading of new pages. Another way to deal with the layout problem is to use a two-way visualization strategy. In a first step a device independent page layout is used. In the second step this device independent page layout is then transformed in to a WML page using all layout elements of the microbrowser of the given cellular phone. To be able to support nearly every cellular phone, it is necessary to use a database, which stores all the display and layout capabilities of the different cellular phone types. Skyware® (http://www.condat.de/english/systemintegration/skyware.htm) from Condat Informationssysteme AG is such a middleware solution.

For graphical representations on screened displays it is very important to follow some design rules to ensure, that the graphics will be readable on the display [1]. These rules contribute to the minimal size of a graphical object or to the minimal distance between them. Of much more importance for small resolution display is the distortion of small fonts and structures. Depending on the relative location of the graphical objects and the given picture matrix image disruption can occur. Due to the rectangular shape of a pixel only structures which are adjusted to the picture matrix can be displayed undistorted. For this reason rectangular shapes are preferred for the display on low resolution displays. Figures 2 and 3 illustrate some effects on low resolution screened displays. In Figure 2 you can see lines and circles, which did not fit into the screen matrix and were therefore distorted.

Fig. 2: Picture distortion on non-vertical or non-horizontal graphical elements

Figure 3 depicts another effect, which might occur in this environment. Not every font can be used on small screened displays. The readability of text highly depends on the chosen font. As an example figure 3 show the strings '123' and 'LfU' each printed in a different font type.

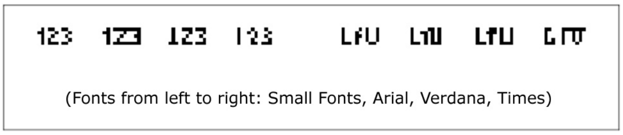

Fig. 3: Different font types shown on a small resolution screened display

Navigation

For a technology like WAP, which is connected with use dependent billing models, an up-to-date and user friendly information offer as well as an efficient access to the information are the key points for a successful service. The information structure finally decides how long a user has to stay online to get the desired information. An ergonomic combination of small, fast ascertainable WML pages and as few as possible navigational steps has to be aspired.

The main problem in many environmental information services is the selection of the area of interest. Think about a WAP service, like the flood prediction service of the Hochwasser-Vorhersage-Zentrale Baden-Wuerttemberg (http://www.hvz.baden-wuerttemberg.de/). This online service offers up-to-date gauges of the important rivers of Baden-Wuerttemberg in the South West of Germany measured at more than 75 measuring points. Without Location Based Services (LBS), which offer the possibility to automatically locate the position of an user, but which could presently only be offered by wireless network providers, the service must present at a first step a maybe hierarchical structured selection list with the names of all gauges. When the user didn't know the name of the gauge he can't access the desired information. Topograms [2] are a solution for this selection problem. Topograms are a special form of a map, which didn't show the topography at the exact scale, but which conserve all topological relationships. Topograms were normally known from the network plans of the public transportation services there they show the direction and the stops of bus or subway lines. In WAP services topograms should be used to give the user a possibility to select a region of interest without to be forced to know the exact name and the exact location of that region.

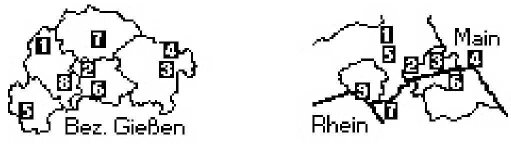

Fig. 4: Topograms depicting air pollutant gauging stations from the district of Giessen and the Rhine-Main area, Germany

In the above shown figure 4 different topograms are given. The numbers in the topograms represent the different air pollutant measuring stations in that region (see section 3). So the user can choose that measuring station which is located closest to his region of interest without being forced to know the name of that measuring station.

3. WAP-BASED ENVIRONMENTAL INFORMATION SERVICES

Based on the described concepts two environmental WAP services were realized. The first one, commissioned by the State Office for Environment and Geology Hesse, focuses on the topic of the air pollutant ozone and on meteorological parameters. The second service, which was realized for the State Office for Environmental Protection Baden-Wuerttemberg, aims to inform the public about the up-to-date local gamma dosage rate of the nuclear power plants in the state of Baden-Wuerttemberg and the nuclear power plants in Switzerland and France, which are located close to the border of Baden-Wuerttemberg.

The **O3-WAP** service offers the public access to ozone concentration and meteorological parameters like temperature, wind speed and wind direction. All these environmental data is measured and recorded by more than 30 automatic gauging stations throughout Hesse. Periodically the recorded data is transmitted to the central office in Wiesbaden and is stored in an Oracle database. The WAP service, which is realized as a servlet, consists of static WML pages, which are stored on the local file system of the server and dynamic WML pages, which were generated on-the-fly by the servlet from the recorded values stored in the database (see Fig. 5).

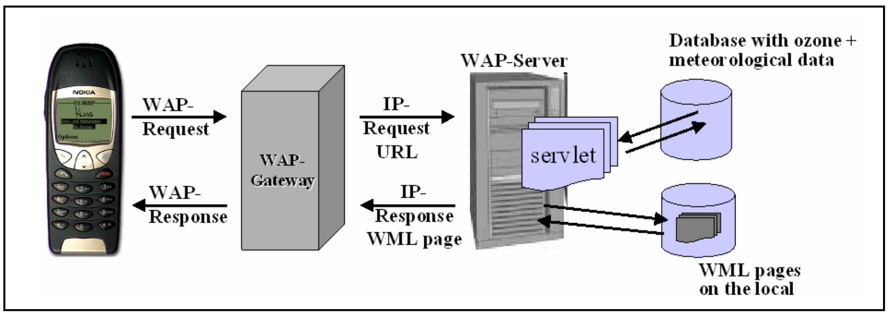

Fig. 5: System architecture of the O3-WAP service

The content of the O3-WAP service is structured hierarchically. In a first step the user has to decide what kind of information (ozone / weather conditions) he is interested in. After this choice he has to select the gauging station. The user has the possibility to select the requested station from an alphabetical or regional ordered list or he uses topograms, which visualize the arrangement of the gauging stations on a map of Hesse. At this point Location Based Services would form a real added value to the O3-WAP service because with their help the O3-WAP service could offer the user the possibility to automatically select the measuring station that is located nearest to the present location of the user. But such a functionality could not be integrated into O3-WAP because due to data protection reasons and due to legislation problems. The cellular phone network provider did not hand on this location information to third part service provider. Therefore such a functionality could presently only be realized by services operated by cellular phone network provider itself and only if the customer of the service has agreed that his location information is used for the service.
Fig. 5 depicts some screenshots showing the selection process of the O3-WAP service.

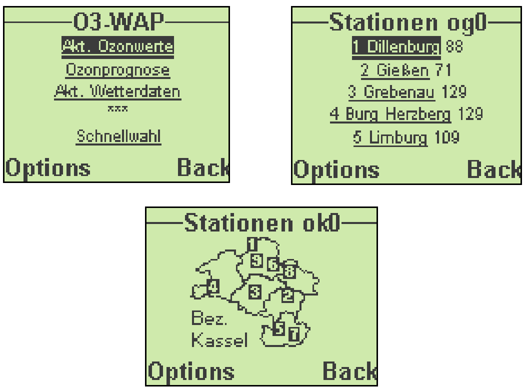

Fig. 6: Menu structure of the O3-WAP service (in German)

Frequent users of the service may use a much faster means of retrieving the up-to-date recordings of a region of interest. Every WML page in the O3 WAP service has its own code. In the main menu the user can enter this code and is instantly directed to the requested page bypassing all subsequent selection menus. Another aspect, which was realized because Location Based Services are at present not available for third part service provider, is the “location reminder”. When the user has chosen a gauging station, this choice is remembered by the service and is available for the future use of the service. As a consequence, the stored region of interest is shown in the top selection level and if the user wants to see the recordings for this station again, he can bypass all subsequent selection steps/menus.
The reception of the recorded measured values is supported, as you can see in Fig. 7, by icons and corresponding diagrams. The icons will help the user to interpret the recorded values. I.e. values above 180 µg/m^3 will be marked with a warning sign and the reception of the wind direction, measured in degrees, is supported by an icon shaped as an arrow. For every station not only the actual ozone concentration is available, but also the ozone concentration for the last 24 hours. The user can access this information by means of a bar chart. This enables him to analyze the course of the ozone concentration.

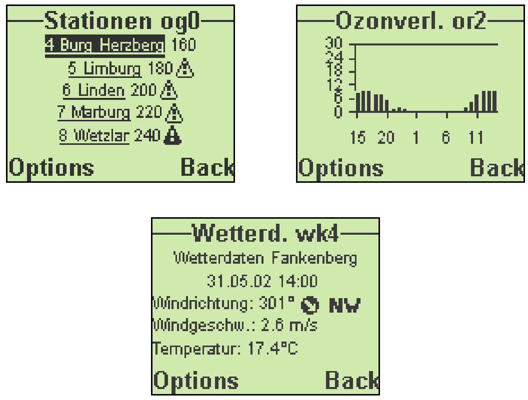

Fig. 7: Information offered by the O3-WAP service (in German)

KFUE-WAP is the name of the WAP service, which was realized for the State Institute for Environmental Protection Baden-Wuerttemberg. KFUE-WAP is an information service that is predominantly designed for the employees of the agency for nuclear power plant observation Baden-Wuerttemberg. Although the public can get access to the data too, the service is not predominantly designed for them. KFUE-WAP offers access to the current local gamma dosage rate recorded at the sites of the five nuclear power plants in the state and close by. For the three nuclear power plants of Baden-Wuerttemberg the dosage rate is updated every 24 hours and the measured dosage rates in the area of the foreign power plants are updated every hour.
The selection process in the KFUE-WAP service is not as complex as in the case of the O3-WAP service, because the number of regions of interest is much lower. However, a topogram was realized to visualize the arrangement of the nuclear power plants, because not every user knows the name of the different power plants and in which area they reside. The topogram offers the user an easy access to the region of interest. Comparable to the O3-WAP service LBS could be used here to simplify the selection process and to point the user directly to the measurements of the nearest power plant location.
The interpretation of the present local gamma dosage rate is supported by two values, which were calculated from the measurements from the previous year. The user is supplied with the current dosage rate, the maximal and the average dosage rate from the previous year. He can compare the present value to the values from the previous year, which helps him to interpret to measured value. For casual users and users which are not familiar with measurement of dosage rates, there is also a short explanation, which gives some hints how to interpret the measured local gamma dosage rate. At this point we like to

stress that the KFUE-WAP service was designed to give the employees of the agency for nuclear power plant observation, which are familiar with local gamma dosage rates and the interpretation of such values, a direct and mobile access to the up-to-date measurements. So in a case of emergency they can get a first impression on the situation without being forced to enter their computers in their offices. The following Figure 8 depicts some screenshots from the KFUE-WAP service.

Fig. 8: Screenshots from the KFUE-WAP service

The system architecture of the KFUE-WAP service is roughly the same as presented for the O3-WAP service with the slight difference, that due to firewall limitations it was not possible to connect directly to the database with the KFUE data (see Fig. 9). Therefore the local gamma dosage rates are extracted from a HTML page, which is part of the internet homepage provided by the State Institute for Environmental Protection Baden-Wuerttemberg.

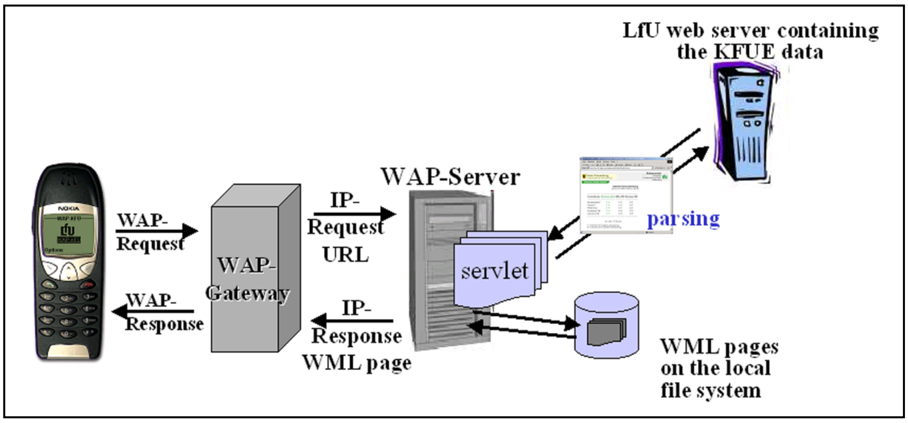

Fig. 9: System architecture of the KFUE-WAP service

3. CONCLUSIONS

After the completion of the implementation work both WAP services were installed on hosts of the corresponding public authorities. After an internal test phase both services have been opened up for public access. First experiences show, that there is a constant but in comparison to the regular internet information offer limited user interest.

During the operation of the service it becomes quite obvious that WAP services presently are not capable to replace introduced information sources like internet, videotext, voice server or print media. But they will gain more and more importance in case the present limitations like display resolution or connection cost will be reduced by future technical enhancements. At present there is no alternative to mobile handsets available, although the size and the resolution of the display are too small for most advanced applications. TabletPCs with WLAN (Wireless Local Area Network) or PocketPCs with GSM adapters may serve as front-end for specialists but they will not be able to replace cellular phones as a public gateway to environmental information services.

At the end of this paper we like to comment on some lessons we learned throughout the project. The experiences we gained show that mainly four things are of high relevance for a successful WAP service:

1. **The information offer must be up-to-date**
   Information, which is only very rarely updated (less than every 1 or 2 days), should be mediated by established media channels, like internet or videotext. Only for up-to-date information can be assumed, that a user is willing to accept the usage restrictions and the relative high usage fees, because the cellular phone might be in that moment the only way of retrieving the desired information. Information of lower up-to-dateness will be gathered at a later date by ordinary media channels, with lower costs and higher usability.

2. **There are only simply means for data presentation available**
   Cellular phones are presently not capable to visualize high resolution graphics or complex text structures. Information offers which consist of these elements as central part are inappropriate to be mediated per WAP. So, if it is not possible to mediate the desired information with simpler representation forms it is presently not possible to mediate such data by WAP services.

3. **The presented data must fulfill a information demand**
   Due to the costs and the reduced navigational opportunities offered by present cellular phones, it is very important to create WAP services, which focus on the user's needs and mediate information with a benefit for the user. Only when the information satisfies a demand of the user he will be willing to pay for it. Therefore it is not desirable to create complex WAP services which integrate lots of different information sources, it is more desirable to create specialized services and integrate these into a portal, so the

user has a chance to get to know about the services he can/should use.

4. **There is no standardization of the microbrowser**
Nearly every microbrowser visualizes a WML page differently. For this reason, present WAP services must use a simple but general page layout, which is supported by nearly every microbrowser or use middleware solutions like Skyware® which adapt the general page layout to the possibilities of the specific microbrowser. But this approach leads to a much more complex system architecture as the one we showed in figure 5 respectively in figure 9.

4. REFERENCES

[1] K. Brunner, S. Neudeck, **Graphische und kartographische Aspekte der Bildanzeige**, in: Telekartographie und Location Based Services, Geowissenschaftliche Mitteilungen, Schriftenreihe der Technischen Universität Wien, Nr. 58, Januar 2002.

[2] E. Arnberger, **Thematische Kartographie**, 3. Aufl., Westermann Schulbuchverlag, Braunschweig, 1993.

[3] U. Freitag, **WAPLuis – Umweltdaten für mobile Endgeräte**, in: Neue Methoden für das Wissensmanagement im Umweltschutz, 4. Workshop Hypermedia im Umweltschutz, Metropolis, Marburg, 2001.

[4] P. H. Johansen, K. Karatzas, J. E. Lindberg, G. Peinel, T. Rose, **Citizen-Centred Information Dissemination with Multimodal Information Channels**, Environmental Informatics 2001, Zürich*, http://www.apnee.org/en/documents/content.htm.*

[5] G. Peinel, T. Rose, R. San Jose, **Customised Information Services for Environmental Awareness in Urban Areas**, ITS 2000. *http://www.apnee.org/en/documents/content.htm*

[6] C. Jarvis, J. Kupiec, **Accessing Public Sector Environmental Data & Information: Development & Demonstration of National Portal**, 16th International Conference Informatics for Environmental Protection, Vienna, 2002.

[7] K. Blankenbach, **Multimedia-Displays: Von der Physik zur Technik**, Physikalische Blätter, 5(55), 1999.