Physical Posters as Gateways to Context-aware Services for Mobile Devices

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Abstract

The concept described in this paper is the usage of physical posters as gateways to mobile services that are related to advertisements and information presented on these posters. In our approach the user can interact through a mobile device with services that are represented by a poster. Our aim is to create a system that allows seamless and natural interaction in the circumstance where users encounter posters. Our work is grounded in an analysis of requirements. We investigated the locations and physical accessibility of posters and the behavior of people waiting in public places. Based on these observations, additional interviews, and an internet questionnaire, we extracted scenarios and present an overall architecture. A prototype, taking into account these findings is outlined at the end of the paper.

1. Introduction

It is commonly agreed that ubiquitous availability of wireless broadband networks combined with powerful mobile devices (e.g. mobile phones, smartphones and PDA's) has the potential to lead to a huge set of new services and applications. A lot of effort is put into the development of new location-based and context-aware services.

Assuming that devices are equipped with a wide set of different network interfaces, a high-resolution coloured display, a basis for downloadable software and a browser for different types of content these services are technically feasible. But why are they so rarely used as a connector to the digital world? Our experience in Germany shows that these services are not used by most users. When talking to people several general reasons are often given why these services are not used e.g.

- users see no need for such services
- it often does not work at all or it is not clear whether or not it will work in the given context
- it is to complicate to use and setup
- it is to expensive for the added value provided

In our research we wanted to find out more detailed what potential problems are and how to build a system to overcome these problems. The first argument (no need for such services) is a non technical statement. We have contradicted this general reason by a study, reported in Section 5 'Expectations in mobile and context-aware services'.

For the other reasons we have looked into more detail. Here we identified four main areas that need to be addressed:

Service Discovery: A significant problem is that the service discovery process is left to the user alone. If, for instance, you are sitting in a restaurant and want to use the online services of the local public transport organization with your mobile device, you have to know under which address you can find the service. But in most cases one does not even know if there exists a mobile service to rent a car, get information about an event, or download or buy a song. More and more search engines for mobile protocols are emerging. The usage of these engines (e.g. Google's Wireless Search [1]) requires the user to fill in forms and a search procedure on the results for the desired items.

Service Protocol Discovery: Another problem is that the potential users do not know which service protocol is used for the desired service. Is there a WAP-version available for the local public transport organization or must I use the XHTML or J2ME (Java 2 Platform, Micro Edition) version?

Network Discovery: Modern mobile devices are equipped with a set of different network interfaces like GSM, GPRS, HSCSD, UMTS, WLAN or Bluetooth. Currently it is up to the user which network and which network provider he/she uses. Particularly in locations like airports where a wide set of different networks and network providers might be available, the user has to choose the best connection regarding e.g. transfer rate and price.

Cost: Another very important problem is that many contracts charge for transmitted data (e.g. WAP- or XHTML-pages, IP-based connections) between the service provider and the user or for online-time. Therefore, many users postpone their online activities to

the time when they have a broadband connection like in the office or at home.

Additionally reasons that hinder the user from taking advantage of mobile services are security concerns and the often difficult and error-prone way to input data into the mobile device.

Taking into account the mentioned problems and regarding the circumstance in which mobile devices are used, we looked for means to ease access to new services. Our general approach is to use physical presented information, such as posters – ubiquitously available in public places - as gateways to context-aware intelligent services for mobile devices.

Posters are an accepted and unobtrusive part of nearly all public places. To use posters as gateways they must be enhanced in some way, for instance with a link information. This can be done by various means, such as a visual code (machine or human readable) or by an access network.

Mobile devices with a camera have become an omnipresent part of every day live. In our research we look at different ways how the connection between the poster and the mobile device can be established. This reaches from pointing at the poster, capturing the poster with the camera, to inputting a code presented on the poster.

The code on the poster has two main functions:

- to make the use aware of the availability of a service
- the automatic selection of the corresponding service, service protocol and network.

Regarding the cost aspect, our considerations include a strategy which prevents the user from paying transmission costs in the vicinity of the physical information display by using a local access network. Other considerations are cost models that do not charge for time or volume.

In this paper we outline how a natural way of interaction between the user, the mobile device and a large number of mobile services related to posters can be implemented.

The paper is organized as follows. The next section relates our work to existing approaches. Section 3 describes two different scenarios illustrating the usage of our concept. This is followed by an analysis of places where posters can be found and of the behavior of people at stops where posters are observable. Afterwards we describe the expectations of potential users in mobile and context-aware services. In Section 6 we present a generic architecture for our concept. Afterwards we depict a prototype which is currently under development. The paper is completed by a discussion and outline of our further work.

2. Related Work

Currently there are a lot of interesting solutions available that allow the extraction of information from different kinds of visual codes most of which connecting this information with corresponding services.

Cybercode [2] from Sony is a visual tagging system for augmented reality based on 2D-barcode technology and cameras in mobile devices. These cameras are used as a sensor to extract the ID number of the barcode and to determine the 3D position of the tagged object. Based on Cybercode they developed e.g. systems to embed links to digital information into physical locations, to develop an indoor navigation system or to annotate the real world by using 3D information.

Rohs and Gfeller [3] presented a concept for recognition of 2D visual codes with a mobile phone that is closely related to the Cybercode approach. Based on the limitations of current mobile devices, they derived requirements for the design of suitable codes and a corresponding recognition algorithm. The authors depict additional prototypical applications and highlight some application areas. This work is based on the ETHOC system [4] that provides a linkage of virtual and physical objects in a smart campus environment.

Airlic [5] provides a similar system that supports usage of mobile information services. It consists of a barcode reader attached to a mobile phone or PDA, a corresponding barcode that is called Smartcodes and the Airlic Mobile Information Platform. Unfortunately, an additional barcode reader which is normally not owned by average users is necessary to use the system.

NTT DoCoMo [6] announced at the Wireless Japan 2003 that some 505 series models will have a QR Code reader which is based on the camera of these mobile phones. QR Code [7] is a standardized 2D bar code that might be used by mobile devices to read a QR Code on magazines or posters and translate it to a URL or an e-mail address. If a lot of manufacturers of mobile devices integrate similar readers such QR Codes in different contexts might be a killer application.

Near Field Communication (NFC) [8] form Philips Semiconductors is a standardized very short-range wireless technology that enables communication between electronic devices. NFC applications can be split into four basic categories where a 'Touch and Go Application' is for instance picking up an URL from a smart label on a poster.

In the context of ubiquitous computing and smart environments, there are also a lot of interesting projects such as HP's Cooltown [9] and the Sentient computing project [10] that are based on the interaction between the user, his/her mobile device and the environment.

Kindberg presented in [11] and [12] partial results of HP's Cooltown where during the resolution of the

identifiers the context of the user is concerned, such as local environmental context or user preferences. Through this, adapted and context-aware services could be provided that better fit the needs of the user.

Beside the connection between the visual code and the service the usage and availability of networks is very important in our context. In addition to omnipresent mobile networks wireless hotspots (e.g. Wirelesses LAN) emerged quickly in the last couple of years. As described in [13] current challenges for these networks are particularly authentication, security, coverage, management, location services, billing and interoperability.

Our concept is based on these approaches, but uses them in a very special application area that we analyzed and described through our scenarios. Furthermore, we are concerned with the whole process based on service discovery, service protocol discovery, network discovery and the provision of the network.

3. Scenarios

After having looked at related work this chapter introduces two different scenarios which show the usage of our concept.

3.1. Movie Poster

John uses the public transport system (particularly bus and subway) in his city for the way to and from his workplace. He spends approximately 60 minutes at the bus station, in the bus, at the subway station and in the subway every day. Additionally, he has to walk between home, work and the different stations. On Monday he goes to the bus stop where he recognizes a movie poster that promotes a new film in which John is interested. He goes to the movie poster, takes his camera-equipped mobile phone, opens the already installed application Simplicity Personal Assistant (explained in Section 6), selects the menu item *Service Recognition*, sees the view finder and focuses on the visual code on the movie poster. The Simplicity Personal Assistant automatically establishes a network connection via the Bluetooth connection between the mobile phone and the Bluetooth access point of the bus station that is provided by the advertising agency. Afterwards, the Simplicity Personal Assistant downloads a J2ME (Java 2 Platform Micro Edition) application to the mobile phone based on the visual code on the poster that refers to that application. This application offers the following three menu items *Download trailer*, *Where & When played*, and *More*. John selects the first item and the trailer gets automatically streamed through the Bluetooth connection and is simultaneously played. After this John decides to invite his girlfriend Clare to this film that evening. Therefore he selects the menu item *Where & When played* to get an additional PDF file containing the dates for cinemas in the neighbourhood (When does the film play where?). Later, Clare and John decide, based on the trailer and the PDF file that they will watch the movie this evening in a cinema that is next to their home.

3.2. Car Rental

John is on a business trip and arrives with the train at Munich central railway station. He leaves the train and searches for the possibility to rent a car. He recognizes that the offices of the car rental firms are really overcrowded. But he recognizes a poster of a car rental firm. He approaches the poster, takes his camera-equipped mobile phone, opens the Simplicity Personal Assistant, selects the menu item *Service Recognition*, sees the view finder and focuses on the visual code of the car rental poster. The Simplicity Personal Assistant automatically establishes a WLAN network connection between the mobile phone and the WLAN access point of the railway station. Afterwards, the Simplicity Personal Assistant downloads a car rental J2ME (Java 2 Platform Micro Edition) application to the mobile phone based on the visual code on the poster that refers to that application. This application offers the following three menu items *Rent a Car*, *Prices*, and *More*. John selects the first item and he has to type in the duration of the car rental, the preferred type of car and the return point. The car rental application offers a proposal based on this data and John agrees. The next form has the title *personal data* and is automatically completed by the Simplicity Personal Assistant. John verifies this information and confirms. The next form has the title *payment* and is automatically filled in by the Simplicity Personal Assistant as well. John verifies this and confirms. The transaction is completed. The car rental application guides John to a locker that John can open through the Bluetooth connection of his mobile phone and the car rental application. This locker includes the keys and documents for the car. Afterwards the car rental application guides John to the position of the car.

4. Analysis – Posters and People

Following the initial interviews we started to systematically analyze prerequisites for such a system. We are interested in two major aspects. Firstly we are interested where posters and adverts are located and how people interact in these spaces. For this we first examined different public places and analyzed the properties of these places. Additionally we observed the behavior of people at such places and in particular at bus stops and rail stations.

In the following we present examples and the conclusions of our analysis. The detailed results can be found on our project webpage, see [14].

4.1. Categories of Poster Displays

In general it can be observed that posters and paper based adverts can be found in nearly any public place. In many cases the information of the posters relates in some way to the place where it is posted. Particularly in locations for public transport systems like airports, railway stations and bus/tram/subway stops a lot of advertisement posters can be found. The posters are mostly attached to the building walls of the airport or the stop. Inside or near these locations advertising columns and notice boards can also be found. Additionally, posters are encountered on places where people spend time like restaurants, cinemas, house walls near streets, crossings, or show windows.

For using such information displays as gateways for access to mobile services the most important attribute of a poster regarding its location is the distance between the potential user and the poster. This distance limits and defines possible interactions.

In general two main locations can be distinguished. First there are posters to which the user can go physically very close. Examples are posters at a bus stop where the potential user is waiting, or an advertising column on the pavement. The user can potentially walk-up very close and touch them. Second there are posters that are out of reach because they are attached in such a way that they can only be viewed from a distance. Usually these posters a bigger and the user can not physically get close. Examples are posters on the ceiling, high up on buildings, or behind a street or railway track.

Considering dynamic aspects again two categories should be considered. First there are places where people can stand for what ever amount of time they want. If they are interested in particular information they can decide to stay in front of a poster and read it carefully. Typical examples are posters in the street. Second there are locations where the users are moved by. In this instance the time the user can spend in front of a particular poster is not determined by the user. Typical examples are large posters on the motorway or close to the railway and posters along an escalator.

In general we can discriminate four different categories as show in the following matrix. There are further dimensions such as the frequency of change and the type of content but they are not central to the system investigated in our research. See figure 1 for examples.

Physical Accessibility	Viewing time: User chosen	Viewing time: Determined by circumstance
approachable		
distance		

Figure 1. Categories of poster displays

This implies that a system must offer different interaction mechanisms that support poster displays that are physically close as well as such that are distant. Additionally it has to be taken into account the time spend in front of a poster is not always determined by the user. Even when the time is determined by the user there are constrains given by the prime task – such a going on a bus to work.

4.2. Observing People and Their Behavior

To get an insight into the time available we observed people and their behavior while waiting for public transport. We wanted to find out how long the passengers are waiting on average depending on the frequency of busses and trams. How many of them come just in time and how many of them do not think about departure times when they go to a stop? Furthermore, we were interested in activities during waiting time. Therefore, we observed about 230 passengers at three different locations.

In our first spot check we observed 100 passengers at a bus stop in Munich between 6.45 and 8.15 am on Wednesday, June 9 2004, a workday. The interval between two busses was 5 minutes then 4 then 10 and then 1 minute. The average waiting time of the passengers was 3 minutes and 13 seconds. As you can see in Table 1, nearly 1/3 of all passengers might have not enough time

to use a mobile service that is connected with a poster because they wait between 0 and 60 seconds. On the other hand, 44% of the passengers were waiting more than 3 minutes which is enough time to use a mobile service.

In our second spot check we observed a total of 100 passengers at two opposite tram stops between 3.40 and 4.55 pm on the same day. The interval between two trams in every direction was 10 minutes. The average waiting time of the passengers was 4 minutes and 37 seconds.

In the following table you can see the distribution of the different waiting times in the first two spot checks.

Waiting time t (in seconds)	Spot check 1 (morning)	Spot check 2 (afternoon)
$0 \leq t \leq 60$	32	8
$60 < t \leq 120$	12	14
$120 < t \leq 180$	12	15
$180 < t \leq 240$	11	9
$240 < t \leq 300$	8	15
$300 < t \leq 360$	5	4
$360 < t \leq 420$	6	7
$420 < t \leq 480$	3	11
$480 < t \leq 540$	7	15
$540 < t$	4	2

Table 1. Waiting times

At the spot check in the afternoon we recognized that there are much more groups and therefore about 20% of the people were talking. During the spot check in the morning nobody made a call whereas 8% of passengers did that in the afternoon.

Based on these observations we concluded that it is very important that the connection between the poster and the service can be established as fast as possible. Furthermore the system should support an operation where the user can move on after the initial link using the poster has been made.

For public transport with a high frequency (e.g. a train or bus at least every 10 minutes) it seems from our observations that people just come to the stop and therefore stay on average nearly the half of the duration between two busses or trams.

A further observation at an S-Train station (metropolitan train, June 15th 2004) with an interval of 20 minutes between trains showed that in this case people come mainly in the last 10 minutes before the train leaves. Here an average waiting time of about 5 minutes was observed. Furthermore it was interesting to see that people who changed their mode of transportation (switching from bus to train) had to wait – even if they planed their journey perfectly. In our sample we saw that many of these people who expected a waiting time carried something to read (mainly newspapers and books). People with waiting times shorter than 4 minutes did not read in the sample group while waiting for the train.

From our observations we can conclude that a key requirement is that the access to a particular mobile service that is of interest to the user is established in a short time; typically this should be less than a minute.

Overall we recognized that most of the people with short waiting times did actually do nothing. We see this as a really good basis for the usage of mobile information services as time killer. Mobile services might be particularly used at places and during the time where people actually do nothing. As has already been described in [15], killing time is a very important killer application. We also saw that people with short waiting times looked quite often at information displays or picked up adverts to and read them on the train. In some trains there are boxes with flyers – and people read them very often whereas in other circumstance they would not look at them.

5. Expectations in Mobile and Context-aware Services

If talking to people about mobile services it is often questioned what there are useful for. We think there is a potential in mobile services and therefore we conducted a web based interview in May/June 2004. We were particular interested in which mobile services potential users might connect with an advertisement poster. For this we introduced a future vision and developed three different questionnaires.

At the beginning we told the participant of the survey to imagine that he/she is in the year 2006, has a modern mobile phone with a coloured high resolution display and a contract with a mobile operator that includes a flat rate for unlimited internet use. Afterwards, an example was outlined which shows possible mobile services which might be connected with a poster advertising a motion picture. In the first questionnaire, nine different posters (e.g. poster from a hotel chain) with a corresponding description (e.g. this is a poster from a hotel chain) were shown to the participant and for each of them a corresponding input area was offered. Here the participant should input which mobile services regarding the poster he/she could imagine. In the next form the same posters were presented but this time the potential user should rate (scale between 1 – 'absolutely irrelevant' to 10 – 'I would use that immediately') different proposed services regarding a poster (e.g. reserve a room in a hotel). In the last form we asked the participant about this gender, age, school-leaving exam and his occupation.

The first form was completed by 28 persons, the second by 29 persons and the third by 24 persons. Through this last form we found out that 83% of the participants were male, most of them (71%) were between 20 and 29 years old and had a university-

entrance diploma (92%). 29% of the participants were students, 25% were clerks, 8% were entrepreneurs and the rest had a different profession. The survey was distributed via email to people in Austria, Switzerland, and Germany.

The eight different posters in our forms advertised: (1) a concert of a pop star; (2) a discount of a car rental company; (3) a home entertainment distributor; (4) a hotel chain; (5) a car of a carmaker; (6) a fashion boutique; (7) speech of a politician; (8) special offers from a flight distributor

The next three tables depict the most important results of the first three posters. The first section of every table shows the results of form 1 and the second section shows the results of form 2:

(1) Poster advertises a **concert of a pop star**	
Proposed services by the potential user	Mentioned by
Order or reserve tickets.	21 of 29 (72%)
Download song fragments, play actual song.	20 of 29 (69%)
Download information regarding the artist.	18 of 29 (62%)
How do I come to the concert?	7 of 29 (24%)
Rating of the predetermined services	Rated (1-10)
Order tickets for the next concert.	6,14
Download actual album or song and play it.	6,34
See information about the pop star.	4,72
See tour dates.	6,41
Send information to a friend.	3,39
Download screen saver of the star.	2,21
Download picture as background picture.	2,03

Table 2. Poster advertises a concert of a pop star

(2) Poster advertises a **discount of a car rental company**	
Proposed services by the potential user	Mentioned by
Information regarding specials offers and prices.	24 of 29 (83%)
Show me the next rental station.	17 of 29 (59%)
Which cars are available? Detailed information about the cars (description, picture).	14 of 29 (48%)
Order or reserve a hired car.	11 of 29 (38%)
Get virtual card (e.g. link, service number).	6 of 29 (21%)
Rating of the predetermined services	Rated (1-10)
Rent a car.	5,93
Get actual prices/offers.	7,59
Calculate price for my desired drive.	7,45
Show me the next rental station.	7,86

Table 3. Poster advertises a discount of a car rental company

(3) Poster advertises a **home entertainment distributor**	
Proposed services by the potential user	Mentioned by
Get detailed technical information (pictures, videos, 3d-animations) of the products.	17 of 29 (59%)
Show me the next store.	17 of 29 (59%)
Check prices.	11 of 29 (38%)
Show me all products (online product catalogue).	7 of 29 (24%)
Where to by in the internet?	5 of 29 (17%)
Rating of the predetermined services	Rated (1-10)
Get information about the actual products.	5,79
Order/Buy a product.	3,24
Where is the next store?	5,55

Table 4. Poster advertises a home entertainment distributor

Based on the first form in our survey we concluded that the people are potentially very interested in the usage of mobile services. We recognized that the participants could imagine a large set of different services which might be connected with different posters. The most interesting service for the users was to get more information about the specific area of the advertisement. For example looking at the poster advertising a discount of a car rental company, 83% of the participants wanted more information regarding special offers and prices (see Table 3) and at the poster promoting a home entertainment distributor, 59% of the participants wanted more technical information (see Table 4).

Particularly products or services that are only for sale in a limited amount, the potential users are really interested in buying. For instance 72% of the users could imagine to order or reserve tickets for a concert (see Table 2). Especially by the poster which advertises special offers from a flight distributor nearly all users (86 %) were interested in looking for and booking of available flights, special prices and last minute flights.

Furthermore, the participants of the survey were very interested in location based services. 24% were interested how to reach the concert or where it's located (see Table 2), 59% were interested in the location of the next car rental station (see Table 3) and 59% were interested in the location of the next store where they can buy special home entertainment devices (see Table 4). Other innovative services have been mentioned like 'Bring the hired car to my current location' by 3 participants (10%).

A further interesting point is that the participants were interested in information and services that are not directly related to the services that are offered by the advertiser. For instance regarding the poster of a hotel chain, 5 of 29 participants (17%) mentioned they are interested in tourist information of the city. Moreover, the participants were interested in aspects that are related to the whole line of

business like price comparisons and products of competitors.

From our survey we are confident that if the right services are provided and easy access is given people will be keen to use them. It was also very interesting to see that given a specific advert or information poster people came up with very specific ideas for related mobile services. Furthermore it is of great interest that there is a convergence in what services people would expect to be linked to poster. Usually a small number off mobile services (e.g. 2 to 5) was identified as the majority.

6. The Overall Architecture

In this section we present an overall architecture that facilitates interaction between the poster and mobile devices. Furthermore, solutions for the problems regarding mobile services introduced in section 1 'Introduction' are described.

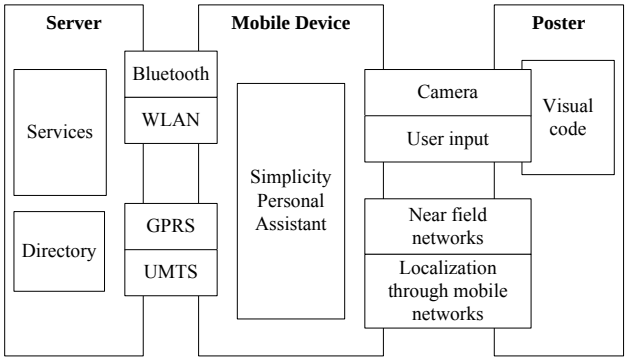

Figure 2. Generic architecture

Figure 2 visualizes the different elements of the basic architecture that are explained in detail in the following subsections.

6.1. Services on the Server

As depicted in Section 5 'Expectations in Mobile and Context-aware Services' there are a lot of services imaginable that are related to posters. Currently there are two main possibilities for the provision of these mobile services in a platform independent way. The first one is the usage of mark-up languages like WAP, (X)HTML or the Synchronized Multimedia Interchange Language (SMIL) [16]. The second possibility is the usage of downloadable applications like Java applications that are based on Mobile Information Device Profile (MIDP) of Java 2 Platform Micro Edition (J2ME) [17].

There is already a huge set of services available, for example from Europcar or from Accor hotels that might also be used in such an architecture. These services can be used "as is" because this architecture provides primarily an easy and direct access to a specific service.

In addition to that there already exists an impressive set of products and scientific projects that address the field of context-aware services which adapt them based on for instance the user (e.g. preferences, location) and his/her devices. Such services are ideal for the proposed system because most of the posters have a strong relationship to the location and environment of the user. An example for such a location-based service is a car rental service that guides the user from the poster to the next car rental station.

6.2. Mobile Device

To use the system the user has to install the Simplicity Personal Assistant (SPA) on the mobile device. This work is performed in the context of the EU-project Simplicity [18]. In this context the SPA is developed and acts as an intelligent interface between the user and the available services, networks and devices. This SPA is also used in our architecture to provide an application on the mobile device that allows the discovering of the poster-based services, their selection and their usage.

The connection between the mobile device and the poster might be established by different mechanisms that have to be based on available sensors. Sensor data could, for example, be gathered by the camera of the mobile device (1), the availability of near field networks (2), the localization functionalities of mobile networks (3) and through a corresponding input of the user (4).

(1) Cameras are an integral part of many modern mobile devices. So the use of these integrated cameras for recognizing visual codes is obvious. Rohs and Gfeller have shown in [3] that with their prototype which is based on a Nokia 7650 (camera resolution of 640*480 pixel) it is possible to recognize visual codes that represent an information set of 76 bits. They also depict that the mobile phone is able to detect ten visual codes simultaneously. But the processing time for the simultaneously recognition is currently too high. The ongoing development of the integrated cameras and the increasing processing power in mobile devices will make it possible to extract all information (service protocol, service and network) necessary for a specific service call. At the moment a directory is needed for establishing a mapping of the identifier at the poster and the concrete service. For the use of the camera as desired sensor, the menu item *Service Selection* has to be chosen after the start of the SPA. This service selection application provides the actual view of the camera. The user has to focus the camera on a visual code representing the service in a special encoding. Based on this, the SPA has access to the services that are related to the poster.

(2) Another possibility to identify the available services is the usage of near field networks like Bluetooth and WLAN. If an advertising column provider installs a corresponding Bluetooth access point at the top of the

advertising column he could offer only the advertised services at the column to the user because the range of this network is limited.

(3) Through the usage of localization functionalities of mobile networks like GPRS or UMTS it is also possible to provide only a specific set of services to the user. Therefore a central directory is needed that stores the detailed position, all viewable posters and their alignment. Based on the detected user position it could be extracted which posters might be viewable by the user.

(4) Manually entering the code is another option. For this the code has to be human readable on the poster. This code could be a number because most users have experiences in the input of telephone numbers. If codes are short this can eases a request of a specific service significantly.

A further possibility not explained in this paper might be based on the Radio Frequency Identification (RFID) technology.

Table 5 shows the different advantages and disadvantages of the mentioned connection mechanisms.

Recognition based on	Advantages	Disadvantages
(1) Camera-equipped mobile devices	The user can interact with the poster in an easy and seamless way.	Some posters could not be focused through the camera in a detailed way because there are too far away. That would be essential, however, for the recognition of the visual code. This could for instance happen when the poster is located on the other side of the street and the user doesn't want to go there.
(2) Near field networks	Services provided by posters that are far off or not touchable could be used.	If there are a lot of posters located in the reception area, the user has to select the intended services by itself. Another solution for this problem is the combination of (2) and (4). Through (2) a small subset of services is addressed from which through (4) one service is selected.
(3) Localization functions of mobile networks	Services that are provided by posters that are far off could be used and no near field network has to be installed.	The installation of a central service for detailed position and alignment of posters is not realizable.
(4) User input	Services that are provided by posters that are far off could be used.	User has to type in a code.

Table 5. Advantages and disadvantages of the connection mechanisms

The SPA as currently developed by the Simplicity project provides additional functionalities to adapt the service based on context information and includes functionalities for automatic completion of forms (e.g. automatic input of user data like address or bank account). But the user has to confirm the usage of this data. So he/she can decide what information is made available to the service provider and what not.

6.3. Poster

Considering the option for sensing discussed in the last subsection there are three different kinds of representations for codes on posters: visual codes readable by a camera, a virtual code in the network and a human readable code. In every case our approach has the advantage that the existing posters might be unchanged or might be only extended by a visual code.

There exist two different possibilities regarding the visual camera readable code. On the one hand that code might represent only an identifier that is unambiguous for the given context. Then there has to be a directory in the network including the different identifiers and corresponding services represented by a URL. On the other hand through the evolving of camera resolution and increasing processing power in mobile devices it will be possible to extract all required information for the service request (e.g. URL, network) from the visual code.

If the recognition of services is based on near field networks or localization functions of mobile networks, a virtual code for every service in the network is needed to establish a service directory. The concrete selection of one service can be done by the SPA itself that offers all services or through a combination with (1) or (4).

When human readable codes are used they might be quite long if they are used alone because they have to represent all needed information for the service request. Through the combination with (2) or (3) relative short codes can be used because the number of services in a certain area is limited.

To support most circumstances it is best to provide a code that is readable by the camera as well as a code that is readable by a human whereas the last one should be supported by (2) or (3).

6.4. Network

As already depicted in Subsection 6.2 'Mobile Device', all available networks might be used in this context. The mobile services as described in Section 5 'Expectations in mobile and context-aware services' would be intensively used if the user does not have to pay the network traffic. If there is a Bluetooth or WLAN access point that might be provided by an advertising company this is not an issue. Another possibility for this is the use of existing mobile networks like GPRS or UMTS where the advertiser pays for the traffic. Basically we see three different options regarding the provision of the network:

(1) Network is provided by network operator + Advertiser pays

(2) Advertiser provides a local network and pays for it. A bus stop could include for instance a Bluetooth or WLAN access point.

(3) Network is provided by network operator + User pays

Furthermore it is very important that the user does not have to deal with all these different networks and their configurations. Most users are overstrained when they have to configure their GPRS connection or even do not know what GPRS actually is. Information regarding the different available networks might be provided by the visual code, by the near field network or by the pre-configured SPA.

If a near field network is used, a problem occurs when the user leaves the range of the network. Therefore a corresponding handover between the different networks is needed.

7. Prototype

Based on the overall architecture we are currently developing a corresponding prototype in the context of the EU-Project Simplicity [18]. Therefore we will deploy an advertising column. As shown in Figure 3 different posters with visual codes will be attached to the advertising column which represents different context-aware services such as a car rental service or a hotel booking service.

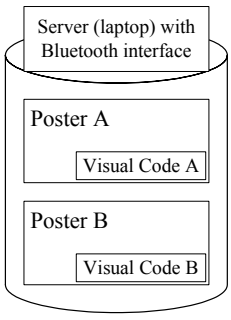

Figure 3. Visualization of the advertising column

The following Figure 4 illustrates the different elements of our prototype (server, mobile phone and poster) and their components.

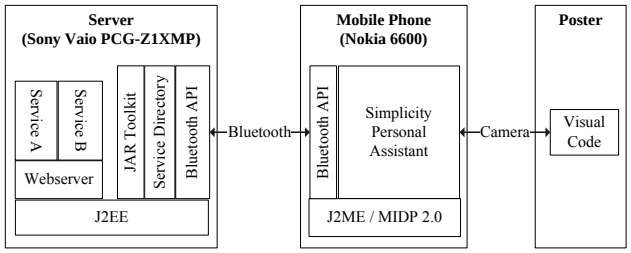

Figure 4. Components of the implementation

Inside the advertising column will be a server located that is represented by a laptop (Sony Vaio PCG-Z1XMP) providing a Bluetooth interface and runs the different XHTML-based services on top of a webserver. Currently we also investigate the possibility of using an IPAQ Handheld computer or a mobile phone as server component.

As the mobile device we envision that many different devices supporting the Mobile Information Device Profile (MIDP) of Java 2 Platform Micro Edition (J2ME) can be used. In our test case we use a Nokia 6600 which has an integrated camera with a resolution of 640x480 pixels that can be addressed by a Java application on this mobile device. A Bluetooth interface is also available which can be addressed by a corresponding API JSR 82 [19] for J2ME. The SPA that is explained in detail in Subsection 5.2 'Mobile Device' will use all these APIs.

In the prototype the SPA is the standard application active on the phone. If the user wants to access information he or she has to focus the visual code on the poster. After a corresponding interaction of the user a picture will be taken. This picture will be transmitted to the server over a Bluetooth connection. There, it will be analyzed by an image recognition component that is based on the JAR toolkit [20]. Thus an identifier is extracted from the visual code. The server includes also a service directory that connects identifiers with services that are represented by a corresponding URL. This URL is transmitted to the SPA that calls the service.

We plan to use this prototype in a study to investigate the interaction between user, SPA, mobile device, poster, server and service. In the next step we look in more detail at how people use this system and we analyze their experiences.

8. Conclusion

In this paper we presented a conceptual system which allows the usage of posters as gateways to corresponding mobile services. The basic idea is that the user can interact through his mobile device with services that are

indirectly represented by a poster in a seamless and natural way. Through our analysis we recognized that there is a potential for such a system; in many locations people spend their time waiting and doing nothing. Furthermore, our initial interviews have shown that potential users can relate specific mobile services to existing posters. Based on this we developed two scenarios which illustrate the use of our concept. Afterwards we presented an overall architecture that includes a discussion how mobile services are provided. We show four different mechanisms that can be used to establish a connection between the poster and the corresponding service. Based on this we discussed how existing posters can be extended and which networks can be used. We then illustrate a prototype to prove our concept.

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