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

Enrico Rukzio, Albrecht Schmidt, Heinrich Hussmann
Ludwig-Maximilians-University Munich
80333 Munich, Germany
{enrico.rukzio, albrecht.schmidt, heinrich.hussmann}@medien.ifi.lmu.de

Abstract

In this paper we describe 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 of users with posters. Our work is based on a requirements analysis. We investigated placement and physical accessibility of posters and the behaviour of people waiting in public places. Based on these observations, additional interviews, and an internet questionnaire, we extracted scenarios and present an overall architecture of our system. A prototype, taking these results into account 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 has the potential to lead to a huge set of new services and applications. Assuming that devices are equipped with a wide range of different network interfaces, a high-resolution coloured display, 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 as to why these services are not used, such as:

- users do not see the 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 too complicate to use and setup,
- it is too expensive for the value provided.

In our research we wanted to find detailed information on potential problems and how to build a system to overcome these problems. Our study, reported in Section 5, provides evidence that contradicts the first of the reasons mentioned above. We found out which mobile services people could associate with a poster. A lot of people could, for example, imagine a service for *downloading songs* when looking on a poster which advertises a pop concert.

Investigating the other reasons, we believe that the following three main areas need to be addressed:

Service Discovery: A significant problem is that the service discovery process is left to the user. Currently you need to know under which address you can find a desired service. In most cases, however, one does not even know if there exists a mobile service. Another problem is that potential users do not know which service protocol is used for the desired service.

Network Discovery: Modern mobile devices are equipped with several different network interfaces like GSM, UMTS, WLAN or Bluetooth. It is up to the user to choose which network and which network provider he/she uses. Especially at locations like airports, where a wide range of different networks and network providers might be available, it is up to the user to choose the best connection regarding transfer rate and price.

Cost: Another very important issue is that many contracts charge for transmitted data between the service provider and the user or for online-time. Therefore, many users postpone their online activities until they have a broadband connection like in the office or at home.

An additional reason that might keep users from taking advantage of mobile services is the often difficult and error-prone way to input data into the mobile device.

Taking into account these problems and the circumstance in which mobile devices are used, we look for means to ease access to new services. Our general approach is to use physically available information, such as posters - ubiquitously available in public places - as

gateways to context-aware intelligent services for mobile devices.

To use posters as gateways they must be enhanced in some way, for instance with links to external information. This can be done by various means, such as visual codes (machine or human readable) or by an access network. The code on the poster has two main functions:

- to make the user aware of the availability of a service
- to automatically select the corresponding service, service protocol and network.

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

We address the cost aspect issue by proposing a strategy which prevents the user from paying transmission costs in the vicinity of the physical information display by using a local access network.

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 behaviour 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 that allow the extraction of information from different kinds of visual codes. Most of them connect this information to related 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, there are systems for embedding links to digital information into physical locations, in order to develop an indoor navigation system or to annotate the real world by using 3D information.

Rohs and Gfeller [3] presented a concept of 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 show additional prototypical applications and highlight some application areas. This work is based on the ETHOC system [4] that provides a link between 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.

Some 505 series models from NTT DoCoMo [6] have a QR Code reader which is based on the camera of these mobile phones. QR Code [7] is a standardised 2D bar code that can 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 large number of manufacturers of mobile devices integrated similar readers, a system using QR Codes in various contexts might be a killer application.

Near Field Communication (NFC) [8] form Philips Semiconductors is a standardised 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 et al presented in [11] and [12] results of HP's Cooltown where, during the resolution of the identifiers, the context of the user such as surroundings or user preferences is taken into account. This means that adapted and context-aware services could be provided that better fit the needs of the user.

Besides the connection between the visual code and the service, 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 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 scenarios. Furthermore, we investigated the needs of people for such mobile services and how this idea fits into the real world. We are also

concerned with service discovery, network discovery and the provision of the network.

3. Scenarios

This section introduces two different scenarios that show the usage of our concept.

3.1. Movie Poster

John uses the public transport system 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. One Monday he arrives at the bus stop where he recognizes a movie poster that promotes a new film in which John is interested. He approaches the poster, gets his camera-equipped mobile phone, opens the pre-installed application Simplicity Personal Assistant (SPA), selects the menu item *Service Recognition* and focuses on the visual code on the movie poster. The SPA 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 SPA opens a specific web site based on the visual code on the poster. This web site offers the following three links *Download trailer*, *Where & When played*, and *More*. John selects the first item and the trailer automatically gets 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 link *Where & When played* to get an additional PDF file containing information about movie programs for cinemas in the neighbourhood. Later, Clare and John decide, based on the trailer and the PDF file that they will watch the movie this evening in a cinema 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 possibilities to rent a car. He recognizes that the offices of the car rental agencies are really overcrowded. Then he encounters an advertisement poster of another car rental agency. He approaches the poster, takes his camera-equipped mobile phone, opens the Simplicity Personal Assistant (SPA), selects the menu item *Service Recognition* and focuses on the visual code of the car rental poster. The SPA automatically establishes a WLAN network connection between the mobile phone and the WLAN access point of the railway station. Afterwards, the SPA shows a specific web site based on the visual code on the poster. This web site offers the following three links: *Rent a Car*, *Prices*, and *More*. John selects the first one and enters his desired duration of the car rental, the preferred type of car and the return point. The car rental web site offers a proposal based on this data and John agrees. The next form titled *personal data* is automatically completed by the SPA. John verifies this information and confirms. The next form is titled *payment* and is automatically filled in by the SPA as well. John verifies this and confirms. The transaction is completed. The web site guides John to a locker that he 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 web site 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. First of all we examined where posters and adverts are located and how people interact in these spaces. To capture this, we first examined various public places and analysed the properties of these places. In addition, we observed the behaviour of people at such places and, in particular, at bus stops and railway stations.

In the following section we present examples and the conclusions of our analysis.

4.1. Categories of Poster Displays

In general, 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. Especially 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. In addition, posters are encountered at places where people spend some of their time. These include restaurants, cinemas, house walls near streets, crossings, or show windows.

In order to use such information displays as gateways for access to mobile services, the most important attribute of a poster, with respect to 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 a user can approach very closely. Examples are posters at a bus stop where the potential user is waiting, or an advertising column on the pavement. The user can potentially come very close to them 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 are larger and the user can not physically get very close. Examples are posters on the ceiling, attached high up on buildings or behind a street or railway track.

In terms of dynamic aspects two categories should be considered. First, there are places where people can stand for whatever 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 users are moving 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 distinguish four different categories as shown in the following matrix. There are further dimensions such as frequency of change and type of content but they are not central to the system investigated in our research. See Figure 1 for examples.

Figure 1. Categories of poster displays

4.2. Observing People and Their Behaviour

In order to get an insight about the time available, we observed people and their behaviour while they waited for public transport. We wanted to find out how long the passengers are waiting on average in relation to 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 such waiting periods. Therefore, we observed about 230 passengers at three different locations.

This was done by three different observers that used the same forms for noting their observations. For every passenger we noted a description that identifies him/her (e.g. young man with a red t-shirt), arrival and departure time, what the person holds in the hands, activities of the person and if this person is part of a group.

In our first sample we observed 100 passengers at a bus stop in Munich between 6.45 and 8.15 am on Wednesday, June 9, 2004, a workday. We chose a bus stop in a residential area because we wanted to analyze the behaviour of people on their way to work. Most people are using the public transport system for driving from home to work in the morning and back in the evening. Therefore we analyzed in particular these two situations. Thus we were able to observe a fairly broad range of people which might all be potential users of our system.

The intervals between two busses were 5, 4, 10 and 1 minutes. 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 may not have enough time to use a mobile service that is connected with a poster because they wait between 0 and 60 seconds. The reason for this is that most people prepare themselves for the arrival of the bus, tram or train. They often look in the direction from which the bus will come and will possibly not use this short time for looking at and interacting with any posters. On the other hand, 44% of the passengers were waiting more than 3 minutes.

In our second sample, we observed a total of 100 passengers at two opposite tram stops between 3.40 and 4.55 pm on the same day. We chose a bus stop in a business area because we wanted to concentrate on the behaviour of people who drive back from work to home. 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 we present the distribution of the different waiting times in the first two spot checks.

At the spot check in the afternoon we recognized that there were 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.

For public transport with a high frequency (e.g. a train or bus departs at least every 10 minutes), our observations indicate that people arrive at the stop without prior

knowledge of the timetables and therefore, on average, wait about half of the duration between two busses or trams.

Table 1. Waiting times of passengers

Waiting time t (in seconds)	Spot check 1 in percent (morning)	Spot check 2 in percent (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

A further observation at an S-Train station (metropolitan train, June 15 2004) with an interval of 20 minutes between trains showed that people mainly arrive 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 had perfectly planned their journey. In our sample we saw that many of those people who expected to wait carried something to read (mainly newspapers and books). People with waiting times shorter than 4 minutes did not read during their waiting period.

From our observations we can conclude that a key requirement is that the access to a mobile service of interest to the user is established in a short time; typically this should be less than a minute. Furthermore, the system should also support an operation where the user can move on after the initial link using the poster is made.

In general, we recognized that most of the people with short waiting times actually did not do anything. We see this as a really promising basis for the usage of mobile information services as a time killer. Mobile services might be particularly welcome at places and during the time where people actually do nothing. As has already been described in [14], 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 advertisements 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

When talking to people about mobile services, the usefulness of these services is often questioned. We think there is a potential in mobile services and therefore we conducted a web based interview in May/June 2004. We were particularly interested in which mobile services potential users might connect with an advertisement poster. For this we purpose 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 showed possible mobile services which might be connected with a poster advertising a motion picture. In the first questionnaire, eight 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. The participants were asked to enter which mobile services could be of interest regarding the current poster. In the next form the same posters were presented, but this time the potential user was asked to 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 gender, age, school-leaving exam and occupation.

The first form was completed by 38 persons, the second by 39 and the third by 34 persons. It is of great interest that there is a convergence in what services people would expect to be linked to a particular poster. Usually a small number of mobile services (e.g. 2 to 5) have been identified as the most-wanted. This implies that the number of filled in forms is sufficient to constitute a representative survey on which services could be associated with which poster.

Through this last form we found out that 82% of the participants were male, most of them (68%) were between 20 and 29 years old and had a university-entrance diploma (94%). In addition, 32% of the participants were students, 21% were clerks, 6% were entrepreneurs and the rest had a different profession. The survey was distributed via email to colleagues and students in Austria, Switzerland, and Germany with a request to forward this email further. Thus, we asked people who use email and have a relationship to computer science because they are colleagues or students. So, as a starting point, we addressed persons who, because of their technical affinity,

are particularly easy to convince to try new technical prototypes.

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) a speech of a politician; (8) special offers from a flight distributor. This selection has been inspired by posters commonly seen in the city representing typical categories.

The next three tables depict the most important results of the first three posters because most participants of the web based interview gave more detailed answers for the first posters. The first section of every table shows the results of form 1 and the second section shows the results of form 2 whereby answers given most often and highest ratings are shown first:

Table 2. Poster advertises a concert of a pop star

(1) Poster advertises a **concert of a pop star**	
Proposed services by the potential user	Mentioned by
Download song fragments, play actual song.	28 (74%)
Order or reserve tickets.	26 (68%)
Download information regarding the artist/concert.	24 (63%)
How do I come to the concert?	9 (24%)
Download tour Information	9 (24%)
Rating of the predetermined services	Rated (1-10)
Order tickets for the next concert.	5,9
Download actual album or song and play it.	5,9
See tour dates.	5,5
See information about the pop star.	4,4
Send information to a friend.	4,4
Download screen saver of the star.	1,8
Download picture as background picture.	1,9

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

(2) Poster advertises a **discount of a car rental company**	
Proposed services by the potential user	Mentioned by
Information regarding specials offers and prices.	32 (84%)
Show me the closest rental station.	24 (63%)
Which cars are available? Detailed information about the cars (description, picture).	23 (61%)
Order or reserve a hired car.	16 (42%)
Rating of the predetermined services	Rated (1-10)
Show me the closest rental station.	7,7
Get actual prices/offers.	7,6
Calculate price for my desired drive.	7,4
Rent a car.	5,6

Table 4. Poster advertises a home entertainment distributor

(3) Poster advertises a **home entertainment distributor**	
Proposed services by the potential user	Mentioned by
Show me the closest store.	22 (58%)
Get detailed technical information (pictures, videos, 3d-animations) of the products.	21 (55%)
Check prices.	13 (34%)
Show me all products (online product catalogue).	10 (26%)
Where to by in the internet?	5 (13%)
Rating of the predetermined services	Rated (1-10)
Where is the closest store?	6,0
Get information about the actual products.	5,5
Order/Buy a product.	3,3

Based on the first form in our survey we concluded that people are potentially very interested in the usage of mobile services. We recognized that the participants could imagine a large set of different services that 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, 84% of the participants wanted more information regarding special offers and prices (see Table 3) and at the poster promoting a home entertainment distributor, 55% of the participants wanted more technical information (see Table 4).

In particular, potential users are really interested in buying products or services that are only for sale in a limited amount. For instance, 68% of the users could imagine to order or reserve tickets for a concert (see Table 2). Especially looking at the poster which advertises special offers from a flight distributor nearly all users (87 %) were interested in looking for and booking available flights, special prices and last minute flights.

Furthermore, the participants of the survey were interested in location based services. 24% were interested in how to reach the concert or where it's located (see Table 2), 63% were interested in the location of the closest car rental station (see Table 3) and 58% were interested in the location of the closest 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 (8%).

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, in connection to the poster of a hotel chain, 7 of 38 participants (18%) mentioned that 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 advertisement or information poster people came up with very specific ideas for related mobile services.

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 are described.

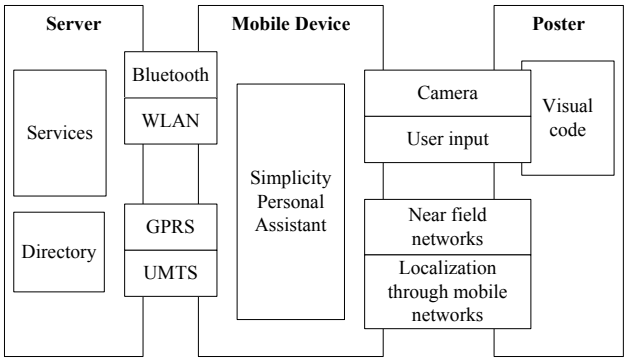

Figure 2. Generic architecture

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, there are a lot of possible services 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) [15]. The second possibility is to use downloadable applications like Java applications that are based on Mobile Information Device Profile (MIDP) of Java 2 Platform Micro Edition (J2ME) [16].

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

In addition, an impressive set of products and scientific projects address the field of context-aware services, by adapting 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 closest 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 [17]. There, the SPA is developed and acts as an intelligent interface between the user and available services, networks and devices. This SPA is also used in our architecture to provide an application on the mobile device that allows discovery of 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. The use of these integrated cameras for recognizing visual codes is obvious. Rohs and Gfeller have shown in [3] that with their prototype, 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 still 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, service protocol 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 or the analysis of the visual code has to be done by a powerful server.

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 printed in a human readable way on the poster. This code could be a number because most users have experiences in entering telephone numbers. If codes are short this can significantly simplify a request of a specific service.

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.

Table 5. Advantages and disadvantages of the 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.

The SPA as currently developed by the Simplicity project provides additional functionality to adapt the service based on context information and includes functionality 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 is not.

6.3. Poster

With respect to the options for sensing discussed in the last subsection, there are three different kinds of representations for codes on posters: a visual code 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 only be augmented by a visual code.

There are two different possibilities regarding the visual camera readable code. On 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 different identifiers and corresponding services represented by a URL. On the other hand, because of improving 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 necessary information (e.g. protocol, URL

that refers to a specific web page related to the poster, available networks) for the service request. By combining this approach with (2) or (3), relatively short codes can be used because the number of services in a certain area is limited.

To support most possibilities, 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, all available networks might be used in this context. The mobile services as described in Section 5 will be more 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 at specific places where a lot of poster are shown (e.g. in an airport or on an advertising column), this is not an issue. Another possibility 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 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 different networks is needed.

7. Prototype

Based on the overall architecture, we are currently developing a prototype in the context of the EU-Project Simplicity [17]. We plan to 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.

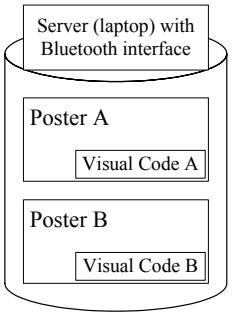

Figure 3. Visualization of the advertising column

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

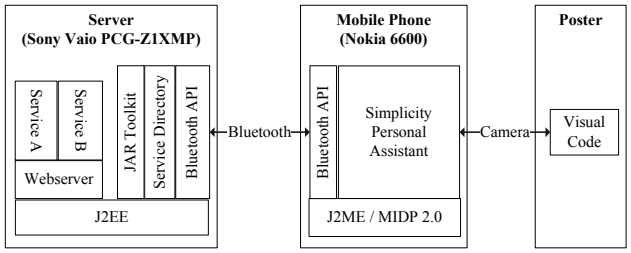

Figure 4. Components of the implementation

Inside the advertising column there will be a server that is represented by a laptop providing a Bluetooth interface and runs the different XHTML-based services on top of a webserver. Currently we are also investigating the possibility of using an IPAQ handheld computer or a mobile phone as server component.

In terms of 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 [18] for J2ME. The SPA that is explained in detail in Subsection 5.2 will use all these APIs.

In the prototype, the SPA is the standard application and by default activated on the phone. If the user wants to access information he/she has to put the focus on the visual code of 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. Because of the limited processing power of mobile phones the visual code must be analysed by a powerful server. There, it will be analysed by an image recognition component. Thus, an identifier is extracted from the visual code. The server also includes 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 will analyse 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/her mobile device with services that are indirectly represented by a poster in a seamless and natural way. Through our analysis we demonstrated 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 data we developed two scenarios that illustrate the use of our concept. Afterwards we presented an overall architecture that includes a discussion on how mobile services are provided. We discuss 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 illustrated a prototype to prove our concept.

9. Acknowledgements

This work was performed in the context of the framework of IST Project Simplicity funded by the EU and the DFG funded research group “embedded interaction”. The authors wish to express their gratitude to the other members of the Simplicity Consortium [17] and the embedded interaction research group [19] for valuable discussions.

10. References

[1] Google Wireless Search
http://www.google.com/options/wireless.html

[2] Rekimoto, J.; Ayatsuka, Y. 2000. CyberCode: Designing Augmented Reality Environments with Visual Tags. In: *Proceedings of DARE, Designing Augmented Reality Environments*, 2000.

[3] Rohs, M.; Gfeller, B. 2004. Using Camera-Equipped Mobile Phones for Interacting with Real-World Objects. In: *Alois Ferscha, Horst Hoertner, Gabriele Kotsis (Eds.): Advances in Pervasive Computing, Austrian Computer Society (OCG)*, ISBN 3-85403-176-9, pp. 265-271, Vienna, Austria, April 2004.

[4] Rohs, M.; Bohn, J. 2003. Entry Points into a Smart Campus Environment – Overview of the ETHOC System. In: *International Workshop on Smart Appliances and Wearable Computing (IWSAWC), Proc. 23rd International Conference on Distributed Computing Systems - Workshops (ICDCS 2003 Workshops)*, pp. 260-266, Providence, Rhode Island, USA. 2003.

[5] Airlic www.airclic.com

[6] NTT DoCoMo http://www.nttdocomo.com/

[7] International Organization for Standardization: Information Technology – Automatic Identification and Data Capture Techniques – Bar Code Symbology – QR Code. ISO/IEC 18004, 2000.

[8] Near Field Communication from Philips Semiconductors http://www.semiconductors.philips.com/markets/identification/products/nfc/

[9] Kindberg, T.; Barton, J.; Morgan, J.; Becker, G.; Caswell, D.; Debaty, P.; Gopal, G.; Frid, M.; Krishnan, V.; Morris, H.; Schettino, J.; Serra, B.; Spasojevic, M. 2002. People, Places, Things: Web Presence for the Real World. In: *Mobile Networks and Applications*, 7(5):365–376, 2002.

[10] Addlesee, M.; Curwen, R.; Hodges, S.; Newman, J.; Steggles, P.; Ward, A.; Hopper, A. 2001. Implementing a Sentient Computing System. Computer, 34(8):50–56, 2001.

[11] Kindberg, T. 2002. Implementing physical hyperlinks using ubiquitous identifier resolution. In: *Proceedings of the eleventh international conference on World Wide Web*, pp. 191-199, Honolulu, Hawaii, USA, 2002.

[12] Kindberg, T.; Zhang, K.; Shankar, N. 2002. Context authentication using constrained channels. In: Proceddings of Fourth IEEE Workshop on Mobile Computing Systems and Applications, Callicoon, New York, June 20 - 21, 2002.

[13] Balachandran, A.; Voelker, G.; Bahl, P. 2003. Wireless Hotspots: Current Challenges and Future Directions. In: *Proceedings of the First ACM Workshop on Wireless Mobile Applications and Services on WLAN Hotspots*. San Diego, September 2003.

[14] Nielsen, J. 2000. Killing time is the killer application. In: *TheFeature: It’s all about the mobile internet. 2000.* http://www.thefeature.com/article?articleid=8183

[15] Synchronized Multimedia Integration Language (SMIL 2.0), W3C Recommendation 07 August 2001
http://www.w3.org/TR/smil20/

[16] Java 2 Platform, Micro Edition (J2ME).
http://java.sun.com/j2me/

[17] Simplicity Project, http://www.ist-simplicity.org

[18] JSR 82: Java APIs for Bluetooth
http://www.jcp.org/en/jsr/detail?id=82

[19] Research Group "Embedded Interaction”,
http://www.hcilab.org/