ORIGINAL ARTICLE

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User needs for location-aware mobile services

Abstract Mobile contexts of use vary a lot, and may even be continuously changing during use. The context is much more than location, but its other elements are still difficult to identify or measure. Location information is becoming an integral part of different mobile devices. Current mobile services can be enhanced with location-aware features, thus providing the user with a smooth transition towards context-aware services. Potential application fields can be found in areas such as travel information, shopping, entertainment, event information and different mobile professions. This paper studies location-aware mobile services from the user's point of view. The paper draws conclusions about key issues related to user needs, based on user interviews, laboratory and field evaluations with users, and expert evaluations of location-aware services. The user needs are presented under five main themes: topical and comprehensive contents, smooth user interaction, personal and user-generated contents, seamless service entities and privacy issues.

Keywords Location-aware services · Mobile services · Usability · User evaluation · User needs

1 Introduction

In mobile environments, all the elements of the context of use may vary a lot. Users are different and they may use the services for many different tasks, even for tasks that were not anticipated in the design. The variety of mobile devices is growing and the users expect to be able to use the same or the same kind of services on the different devices. The technical and service infrastructure may differ and they may even change in the middle of a

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usage session, e.g. the network or the positioning system may change when the user moves from one place to another. Similarly, the service infrastructure, i.e. the available services and applications, may change. The physical context may vary a lot in terms of illumination, background noise, temperature and weather. The use of the device may affect the social situation in which the user finds him/herself or the social situation may affect the way the user uses the system.

An efficient way of improving the usability of mobile services and applications is to adapt the contents and presentation of the service to each individual user and his/her current context of use. In this way, the amount of user interaction will be minimised: the user has quick access to the information or service that (s)he needs in his/her current context of use. The information can even be provided to the user automatically.

A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task [1]. The main problem with context adaptation is that the context cannot be easily identified or measured. The location of the user is an element of the context that currently can be measured more or less accurately depending on the positioning system in use. In this paper, location-aware services are defined as context-aware services that utilise the location of the user to adapt the service accordingly. Location-based services are services that are related as such or by their information contents to certain places or locations. Thus location-aware services are a special case of location-based services.

So far, context-awareness has mainly been studied from the technical point of view and the studies have concentrated on location. Different experimental systems have been set up but only a few user evaluation results from small-scale trials are available. Location-aware services are a concrete step towards context-awareness. Other aspects of context-awareness will follow as soon as the corresponding elements of the context, such as weather or the social situation, can be measured and the adaptivity needs can be identified.

This paper studies location-aware mobile services from the user's point of view. The paper draws conclusions about key issues related to user needs, based on user interviews, laboratory and field evaluations with users, and expert evaluations of location-aware services.

2 Methods of locating the user

From the point of view of the service, the simplest method of locating the user is to let him/her tell the location. From the point of view of the user, this method requires extra effort because the user needs to define his/her location and input it to the system as a part of the search.

The user can be located with different positioning systems. If the user device includes a GPS (Global Positioning System) module, the user's location can be defined very accurately (2–20 meters). A GPS cannot be used indoors and it may not work in 'urban canyons' either. The location is calculated in the user device and it has to be sent to the service provider in order to get location-aware services. The range of commercial products currently available include mobile phones with integrated GPS modules, separate GPS modules for PDAs (Personal Digital Assistant), and GPS devices with integrated mobile phone and data features.

A mobile phone can be located by the telecom operator in the network. The positioning is based on identifying the mobile network cell in which the phone is located, or on measuring distances to overlapping cells. In urban areas the accuracy can be down to 50 meters, whereas in rural areas the accuracy may be several kilometres. The advantage of the cell-based positioning method is that the user needs no extra equipment - an ordinary mobile phone will do. If the user wants to use location-aware services from other service providers, the location has to be transferred to the other service provider and the telecom operator must get permission for this from the user. The location data is possessed by the telecom operator, which may not be willing to pass it on free of charge. Possibly because of these data transaction needs, current cell-location-based services are provided mainly by telecom operators.

The user can also be identified at a service point, utilising e.g. WLAN (Wireless Local Area Network), Bluetooth™ or infrared technologies. These kinds of proximity positioning systems require a dense network of access points. The density of the network depends both on the required location accuracy and on the range of the access points. The accuracy can be down to 2 meters. The user needs special equipment, although WLAN and Bluetooth, for instance, are becoming increasingly common in current mobile devices. Because of the required infrastructure, such systems can only be used in a predefined area, e.g. a shopping centre, an exhibition area or an office building. The location of the user is available only when the user is in the service area.

3 Recent research on context- and location-aware services

Context-awareness can be implemented as an adaptation of the user interface or the contents of the service. Services can also be invoked based on the identified context.

A context-aware user interface can select the appropriate modes for service interaction. A context-aware user interface can also be implemented e.g., as context-aware text prediction [2] or a location-aware remote control for the environment [3]. A major challenge for the context-aware user interface is that the context may be continuously changing. This raises the problem of integrating changes into the user interface in such a way that the user remains in control [4]. Moving can also be seen as one mode of interaction with the system. This interaction mode is quite challenging because it is difficult to know the user's intention: is the moving really taking place in order to interact with the system [5].

In recent research, context-aware contents have been studied in different application areas, e.g. tourist guidance [6], exhibition guidance [7], e-mail [8], shopping [9], mobile network administration, medical care and office visitor information [10]. In these studies, the location of the user is the main attribute used in the context-adaptation. In well-defined application areas, it is possible to predict the other elements of the context according to the location of the user. Designing for more general user groups and wider contexts of use will be much more challenging.

4 The empirical studies

4.1 Scenario evaluations

We have carried out several empirical studies to study user attitudes, needs and preferences for location-aware services. We started with scenario evaluations in group interviews. The aim of this evaluation was to study broadly the attitudes of the potential users towards different personal navigation services. Future possibilities of personal navigation products and services were presented to the interviewees as pictured scenarios of everyday life. In addition to location-based services, the scenarios also introduced route guidance services, services for tracking property and services based on locating other people.

We had 13 evaluation groups, each with 3 to 7 people, totalling 55 persons of different ages, different backgrounds and from different parts of Finland (Table 1). The groups were selected so that they broadly represented the potential users of personal navigation services. The groups included four families, three hobby groups (football players, boaters and hunters), two youth groups, senior citizens, a group of motor-disabled people, a group of visually impaired people and students of well-being technology. The groups were somewhat

Table 1 User groups in the scenario evaluations

Group	Female	Male	Ages	Mobile phone owners (%)	Regular computer users (%)	Have been using navigation device (%)	Locality
Family 1	1	1	36–39	50	100	–	Urban, Northern Finland
Family 2	1	1	34–36	100	100	–	Rural, Southern Finland
Family 3	2	1	14–45	100	67	33	Rural, Western Finland
Family 4	1	1	15–46	50	100	–	Urban, Northern Finland
Football club	–	3	25–27	100	100	–	Urban, Western Finland
Sailing club	1	6	32–55	100	70	70	Rural, Western Finland
Hunting club	–	4	38–44	75	50	75	Rural, Northern Finland
Youth group 1	3	2	17	80	80	20	Rural, Northern Finland
Youth group 2	–	5	15–16	100	60	20	Rural, Western Finland
Senior citizens club	2	3	56–66	100	80	20	Urban, Western Finland
Disabled people at a service house	2	3	24–50	60	60	20	Urban, Western Finland
Visually impaired	2	3	27–46	100	80	20	Urban, Western Finland
Students of well-being technology	4	3	21–37	100	100	29	Urban, Northern Finland
Total	19	36	14–66	90	78	29	

male-oriented, mainly because of the selected hobby groups. We wanted to include boaters and hunters because these groups are already familiar with navigation devices and thus might be early adopters of new personal navigation services.

Each group evaluated between three and five scenarios that were selected so that they presented the different aspects of personal navigation and were targeted according to the group.

The original scenarios were written in 1999 by a multidisciplinary team of experts, as a part of setting up the Personal Navigation Research and Development Programme in Finland [11]. We modified the scenarios so that they reflected the present situation in the research and industrial fields, and so that they covered different aspects of personal navigation. We also wrote some brand new scenarios, targeted specially at different age and/or hobby groups.

The scenarios described location-aware advertising in the form of junk mail, a visit to an exhibition, different holiday and working trips, meeting friends in the eve-

ning, going to work and shopping. The scenarios were short stories of everyday life, illustrated with pictures of the context of use and imaginary mobile devices and services. Figure 1 presents a part of the scenario of location-aware spam.

The scenarios were delivered to most of the groups in advance, so that the participants could read the scenarios before the interview. In the semi-structured group interview, the scenarios were discussed one at a time. The evaluators presented the scenario to the group and started the discussion by asking the interviewees how credible they considered the scenario, and why. Figure 2 illustrates the group interview with the senior citizens.

4.2 User evaluations

We have also evaluated with users different commercial location-aware services in Finland. The aim of these evaluations was to identify good solutions in current services as well as user needs for future services. Benefon

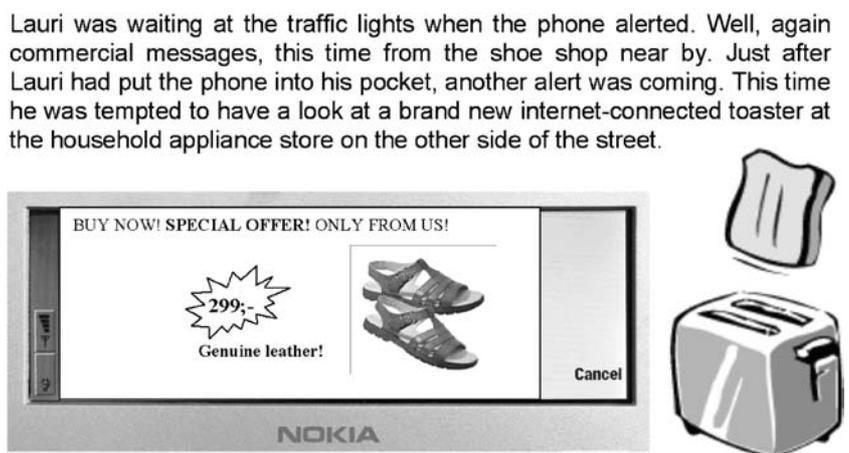**Fig. 1** Part of a scenario describing location-aware spam (translated from Finnish)

Lauri was waiting at the traffic lights when the phone alerted. Well, again commercial messages, this time from the shoe shop near by. Just after Lauri had put the phone into his pocket, another alert was coming. This time he was tempted to have a look at a brand new internet-connected toaster at the household appliance store on the other side of the street.

BUY NOW! **SPECIAL OFFER!** ONLY FROM US!

299;-

Genuine leather!

Cancel

NOKIA

Fig. 2 Group interview with senior citizens

Esc! (Fig. 4) is a mobile phone that includes an integrated GPS system. When the Benefon Esc! is used together with a Yellow Pages short message service (SMS), the user can get information on nearby services as well as their location, which the Benefon Esc! can display on the map screen. The Benefon Esc! was evaluated outdoors in the city of Tampere with six male users: three students and three middle-aged men (aged 59–62) having fishing and hunting as their hobby. We ended up with a male user group because of the hobby group selected.

In Finland, Sonera Pointer (Fig. 4) was one of the first location-aware WAP (Wireless Application Protocol) services that utilised cell-based positioning. Pointer Bensa (Gasoline) gave information on the cheapest gasoline stations in the vicinity of the user. Pointer Opas (Guide) offered information about the district around the user: sightseeing and attractions, events, activities, accommodation and tourist information. Pointer Fakta (Facts) gave statistical facts about the city or municipality in which the user was located. The Pointer services were evaluated in our usability laboratory with five users, three women and two men, aged 25–64, and with different backgrounds. Only one of the users had previous WAP experience. One of the users did not own a mobile phone himself.

The evaluations of both Benefon Esc! and Sonera Pointer were carried out in four phases. The evaluation started with filling in a background form to collect user data and information on his/her experience, e.g. with mobile phones and services. Then the user carried out test tasks that were combined with a frame story ("You are driving from Helsinki to Jyväskylä. Near Tampere you notice that you would need to fill up your car..."). After the test tasks, the user could use the system freely, if there was time left and if the user wanted. Finally, the user was interviewed about his/her general impressions of the evaluated service. One evaluation session took about two hours. The laboratory evaluations were recorded on video, whereas the outdoor evaluation was recorded on audio and as photographs of usage situa-

tions. Figure 3 illustrates a user evaluation of Benefon Esc!.

In addition, we evaluated with five users a traditional GPS device (Garmin GPS 12) and a GPS module on a PDA (Magellan GPS Companion for Palm). These devices and the map services on them may not be considered as location-aware services as such, but still they are important support services for the users of location-aware services.

4.3 Expert evaluations

We also reviewed some services in expert evaluations because these services were not available in Finland. CeBIT 2001 Mobile Fair Guide (Fig. 4) was a tradeshow guide for PDA computers. The software together with the Fair Catalogue could be downloaded from the web.

Fig. 3 Evaluating Benefon Esc! with a user

Fig. 4 Some of the evaluated devices and services: the Benefon Esc! GPS phone, Sonera Pointer on a WAP phone, Cebit2001 Guide and Vindigo on a PDA

During the fair, there was also a demonstration on using the guide together with a Bluetooth-based indoor navigation system. Pocket Streetmap (www.pocketstreetmap.com) is a map software for PDAs, which also includes some location-based services. Vindigo (Fig. 4, www.vindigo.com) is a location-aware service guide for local entertainment, shops and restaurants in major cities in the USA and in London. We reviewed the Cebit 2001 Guide at the trade fair in Hanover, whereas Pocket Streetmap and Vindigo were reviewed in London.

The group interviews were carried out in spring 2001 and were followed by the user and expert evaluations from summer 2001 to spring 2002. In the following section, the results of all the above-mentioned evaluation activities are discussed as key issues to consider when defining user needs for location-aware services.

5 User needs for location-aware services

This section presents our main findings about user needs of location-aware services. The findings are grouped under five main themes: contents, interaction, personalisation, service entities and privacy. As a starting point, Sect. 5.1 presents an overview of user attitudes identified in the group interviews and evaluations.

5.1 User attitudes

The attitudes of the users towards location-aware services were quite positive both in the group interviews and in the user evaluations. Location-aware information was expected to be especially useful in special situations, e.g. in unfamiliar environments, when looking for a specific service or in emergency situations. Location-aware information on parking lots, detours and contemporary events such as concerts and football matches was found useful. The disabled users would appreciate accessibility information, and the visually impaired pointed out the importance of speech-based systems.

However, criticism of new technology was brought up in many group interviews. A predestined and over-controlled environment was seen as dubious, and the interviewees did not accept the rational and purpose-oriented attitude to life that they identified in the scenarios. In addition, some of the scenarios, for instance proactive shopping and exhibition guides, were seen as going too far beyond the real needs of people. The Exhibition scenario presented a system that guided the visitor along a predefined route, pointed out people that the visitor should meet, and offered a possibility to make appointments to popular stands. Almost all interviewees commented that these kinds of systems might be useful for 'some businessmen' but not for them. The interviewees were mainly familiar with quite small exhibitions where the idea is to 'just wander around anyhow'. The Boater group and Family 1 also pointed out that setting up the system before the exhibition visit might become a major task. In some groups, the Exhibition scenario catalysed discussions where the interviewees identified useful applications for this kind of service. In the Senior citizens group, one lady told about using an automatic guidance system in a submarine museum in the US. The group agreed that the system should provide local information when needed but should not keep to a predefined route. The group also innovated a city guidance system based on the same idea.

Participants in the user groups mainly wanted solutions to ease their life in certain functions, but the aim of ultimate effectiveness itself was seen as bad. The interviewees thought that the location-aware reminder presented in one of the scenarios created a feeling of haste; the servant becomes a master that starts to give commands to the user. Fear of radical changes in human interaction, the usability of systems and the narrow use of new services and products were also raised in the groups.

5.2 Contents

5.2.1 Topical information

In the interviews and user evaluations, topical information turned out to be important to the users. This is the kind of information that may change while the user is on the move, in which case the information checked previously from other media (e.g. newspaper, TV or Web) may no longer be valid. Examples of such topical information are traffic information, weather forecasts, last-minute theatre ticket deals, or on-line chat. Unfortunately, in the evaluated services the only somehow topical information was included in Pointer Bensa (Gasoline), where gasoline prices at different service stations were updated once a day. In the group interviews, the Senior Citizens group as well as the Boaters group pointed out emergency situations, e.g. roadside help in a situation when the car breaks down. In this kind of situation, the traveller would need information on where (s)he could get help immediately, rather than a general service catalogue. Three Sonera Pointer test users also expressed a need for roadside services.

In addition to topical information, the users will need guidance on how to proceed in the changed situation. For instance, a train schedule as such can be obtained elsewhere but once on the move, the user will need information on delays and estimated arrival times. Furthermore, the service could suggest alternative routes in case of delays. The need for topical information is much greater than the Web is currently providing. This sets high expectations for the systems that maintain information as well as for the mechanisms by which the user will be informed and alerted.

5.2.2 Comprehensive contents

Although a mobile service on a small device can give only small portions of information to the user at a time, the user should have the possibility to access further information as exhaustively as (s)he needs. This need has been identified in other studies as well [12].

In the user evaluation of the Yellow Pages service, a user was looking for the closest restaurant with a dance floor and found that it was over 100 km away. The service did not include any of the dozens of restaurants with this facility in the city where the service was evaluated. The limited content of the services available was one of the main reasons why users considered the services not useful. The users expected to get some idea of the extensiveness of the contents as well as the geographic area that the service covers to be able to assess the usefulness of the service. Starting up a service will not be easy: on the one hand, a critical mass of service providers will be needed to get the users in, and, on the other, a critical mass of users will be needed to get the service providers in. It should be considered carefully how much content a pilot service should be included to be worth releasing.

The Cebit 2001 Guide did not have such problems because the exhibitors at a trade fair are an entity that can quite easily be managed. The earlier user evaluation results of the CeBIT2000 exhibition guide by Bieber and Giersich [7] point out that users wanted to have both more extensive information about the trade fair itself (more information about the exhibitors and more extensive search possibilities), and more information about the immediate surroundings (e.g. a shuttle plan of the fairground and overall travel information). It is not wise to restrict the available information only to the current location and time: the users may also need to plan their next activities or to return to previous activities.

Although the user groups in our evaluations were small, the results point out that information and service needs vary, not only according to the location but also according to the user and the usage situation. In one test task, the users were looking for accommodation information from the Sonera Guide. All the users missed some additional information about the hotels, but the type of information required varied. Some users would have liked to get information on price and room availability; some would have liked to get more information about the location, some about the quality and facilities. Similar variations in user preferences could be identified in making a reservation and in getting route information. The users will need comprehensive information both in breadth (number of services included) and depth (enough information on each individual service).

5.3 Interaction

Location-aware services differ from many other types of mobile services because they are not just mobile in the sense that they can be carried with the user but they are actually used on the move. The usage situations are demanding because the user can often devote only partial attention to the device, concentrating on his/her primary task of moving. In addition, the physical environment (e.g. background noise, illumination, weather) may disturb the usage situation.

5.3.1 Push or pull

In the group interviews, most users thought that they would not mind having the service or information pushed to them as long as the provided service or information was really what they needed in the situation. The attitudes of the young users (Youth groups 1 and 2; Students of well-being technology) towards location-aware ads was very positive, although the teens pointed out that they wanted the ability to select what kind of ads, from whom and when they received. The attitudes of the older interviewees were also mainly positive but more prudent. Some of the older interviewees said that they just do not like ads in general. Although the attitudes of the users were positive, location-aware push services should be designed carefully. Attitudes will soon change if the users find themselves continuously receiving information that they do not need.

In most cases, location as such is not enough to activate push but location should be complemented with personalisation. Excess content must be avoided, but at the same time the user must get an interesting, up-to-date and useful service from his/her personal point of view. User needs for personalisation are discussed in Sect. 5.4.

5.3.2 Detailed search options

When evaluating the Yellow Pages service, one person was looking for a restaurant with a dance floor, another for a vegetarian restaurant, and a third for a moderately-priced lunch restaurant. In our trial, the Yellow Pages service made no distinction between different kinds of restaurants. The probability of satisfying the user need in the search was near to chance. When getting information about gasoline stations with Sonera Bensa (Gasoline), the users in the evaluations said that in many situations they would have a greater need for information on the nearest or next gasoline station on the route than on the cheapest one provided by the service.

Vindigo provided shopping guidance by classifying the shops into women, music, sports, electronics etc. On the basis of our user interviews and evaluations, this kind of classification seems to be on too general a level. The users would benefit more from a classification based on the items that the user is looking for, e.g. tennis shoes, music scores or mobile phones.

Location-aware guidance services should provide accurate searches, both at the level of the search criteria

and the classification of information. Similar needs have been identified in mobile services in general [12].

5.3.3 Planning versus spontaneity

An important issue is whether the user needs the information when (s)he is at the given location, before getting to the location, or when planning the visit. Some information or options may be needed only after the visit. Flexibility of use requires that the services should support both pre-trip planning and on-route information on occasionally found points of interest. In general, the user should be able to utilise the services without any pre-made plans.

Our scenarios of use presented active users who plan their visits carefully and configure their devices accordingly. While travelling around, the users are ready to fine-tune the settings and respond to all kinds of inquiries from other travellers or service providers. The same attitude could be recognised in some of the evaluated services. This is partly because of the slow mobile networks that require the user to pre-load the necessary maps and other information using faster fixed-line connections. In practice, people may not be willing to spend their time on something from which they do not get immediate benefit. In particular, people tend to be busy while on holiday; they do not want to waste a single minute of their holiday time.

In the user evaluations, most users thought that they would use location-aware services occasionally and mainly in unfamiliar environments or in emergency situations. These needs indicate that the services should be easily available when the spontaneous need for them arises. The services should be easy to find, easy to take into use and use thereafter.

The users in our interviews said that location-aware systems should not lead to a predestined and over-controlled environment. The user should feel and be in control. Similar needs have been identified in other studies as well. Cheverst et al. [6] state that the user should be able to override the recommendations of the system. Fano [9] and Espinoza et al. [13] point out that the user should have the alternative of using the system in an explorative way, i.e. having a look around without any predefined goals.

5.4 Personalisation

5.4.1 Personal options and contents

The contents of the evaluated services were quite limited and thus it is understandable that the services did not include any personalisation options. However, when the users in the evaluations described the kinds of information that they were missing from the services, it was evident that there are personal variations in preferences for both the contents and the presentation.

Also, location-awareness as such seemed to create an impression of personal entry to the service, e.g., quoting one of the test users of Sonera Pointer: "Does this phone know that we are in Tampere?"

Personalisation in location-aware services is a good way of improving the usability of the services by providing the most essential information and the most probable options easiest available. Earlier studies on personalisation [14–16] indicate that, although the users were interested in personalised services, the motivation to actually do something for this is often quite weak. Hollensberg and Vind Nielsen [17] suggest that with WAP (Wireless Application Protocol), personalisation is a highly advanced feature, which WAP users will explore and use later, if ever. On the other hand, Ramsay and Nielsen [18] point out that personal and localised services are where WAP should be able to make an impact. It is a big design challenge to design personalised location-awareness so that it does not require too much effort on the part of the users.

The user may personalise the system according to his/her preferences but if the preferences are different in different locations, configuring the system for all these locations becomes a major task. Ways of assisting the user in the personalisation of the system are worth considering. Cheverst et al. [19] point out the need to make the user profile persistent, enabling the use of the same profile with other services as well, e.g. in the next city to be visited. Collaborative filtering can be used to identify similar users and to adapt the system according to the group profiles. The user should also be able to use the same profile with different devices.

5.4.2 User-generated contents

Far too often users are seen as passive information consumers. However, letting the users participate and provide their opinions and recommendations could enhance many services. Such contents may enrich the service, bringing in additional users and encouraging a sense of community among users. The dynamically changing information generated by other users at a particular location may be better suited to the needs of the next visitors than a more general type of information that is provided externally. The users would also benefit from the possibility to store, access and share with others their own location-based information: notes, photos, etc. [13,20,22]. The system can also identify locations frequently visited by the user and then assist the user in associating information with these places [22]. Shared contexts can encourage a sense of community among visitors [19].

In the user evaluation of the Benefon Esc!, the users appreciated the possibility to generate and store their own information related to locations that were personally important to them. In the group interviews, information provided by other visitors at the same place was deemed interesting. However, most users did not accept the idea of being contacted by strangers.

5.5 Seamless service entities

5.5.1 Consistency

With the Sonera Pointer Services, a number of usability problems arose because of inconsistencies in different Pointer services. The logic employed to navigate backwards in the services did not stay the same in different parts of the services. Some pages were organised so that links to the previous and front page were in the middle of the page. Most users did not notice that the page was continuing after those links. In one test task, the users got information on age distribution in the city of Tampere from Pointer Fakta (Facts). When reading the long list on a small screen, the users easily lost the focus and could not say which information was belonging to which age class. In this kind of lists, individual data fields should be marked consistently.

When the choice of services grows, and since the contents may come from several separate service providers, consistency becomes even more important. The user learns to use the services more easily when the information contents and structure remain similar in the different services. When travelling abroad, the user would appreciate familiar-looking services that are consistent with the services that (s)he is using at home. The internationalisation and localisation of location-based services is challenging because the local services will probably have both local users and domestic as well as foreign visiting users [21].

5.5.2 Seamless solutions support the whole user activity

In our evaluation, some of the evaluated products were designed for route guidance and some for location-aware services. On the one hand, when using route guidance services, the users often missed information about places and nearby services. On the other hand, when using location-aware services, the users expressed a need to get route guidance to the place of interest. They also wanted to have easy access to phone numbers, e.g. the possibility to call the given hotel to make a reservation. Ideally the user should see all the necessary information for a given task in a single view. The information and the options should be accessible directly from the point in the service where the need for that piece of information or option arises. The design should aim for a seamless solution whereby the user is supported throughout the whole usage situation.

Cheverst et al. [6] point out the need to be able to use the mobile system both on and off line. Connectivity affects functionality, e.g. the availability of interactive services. In our evaluations we identified similar needs – the connection may not always be on, but nevertheless the user should be provided with as much functionality as possible. For example, the users of Sonera Pointer wanted to save the search results for later reference.

5.6 Privacy

Privacy protection in location-aware services is related to the right to locate a person, use the location, store the location and forward the location. Current legislation is the basis for privacy protection but social regulation can also create rules and norms for different situations in which location-aware services are used [23]. Espinoza et al. [13] emphasise the right of the user to remain anonymous. Marmasse and Schmandt [22] suggest that problems with privacy could be avoided by performing location tracking and analysis solely on the client device. Ljungstrand [24] and Ackerman, Darrel and Weitzner [23] point out the trade-off between privacy intrusion and user benefit. They think that, if the benefit is perceived as large enough, some degree of privacy loss will probably be accepted. Continuous requests for permission may overwhelm the users and may disturb the user in his/her activity.

The World Wide Web Consortium (W3C) has defined the Platform for Privacy Preferences Specification (P3P). This specification allows web browsers to interpret the privacy practices of the Web sites and compare these with the predefined user preferences for privacy. Then the user does not have to consider privacy issues separately with each individual Web site [25]. This kind of approach could also be utilised with location-aware services.

Privacy can also be affected by the selected input/output modes of the system. Speech-based interaction may create privacy problems when used in public places [22]. Bisdikian [26] points out that using public terminals as private displays may also create privacy problems.

In our group interviews, people were worried about their privacy and the "big brother" phenomenon when considering services enabling people to be located. However, the interviewees were not worried about privacy issues with location-aware services. It did not occur to most of the interviewees that they could be located while using the service. If they did understand this, they seemed to put a great deal of faith in the current telecom operators: "The telecom operators will guard that kind of information. They already have all kinds of information about me but do not distribute it around". It was also commented that there would be regulations and legislation protecting those who use location-aware services. The danger of someone somehow abusing their knowledge of the user's location came up only occasionally in the group interviews. In the Sonera Pointer evaluation, two users spontaneously mentioned invasion of privacy as a potential threat in location-aware services.

The location-aware services should inform the users of what kind of data is collected, how is it used and who has access to it. The faith that the users have in the technology, the service providers and the policy-makers should be regarded highly. Any abuse of personal data can betray that trust and it will be hard to win it back again. The user should be able to flexibly control the

release of private information such as his/her location at a given time. The user should be allowed to remain anonymous when (s)he wants.

6 Conclusions

Mobile contexts of use vary a lot and may even be continuously changing during use. The context is much more than location, but its other elements are still difficult to identify or measure. Location information is becoming an integral part of different mobile devices. Current mobile services can be enhanced with location-aware features, thus providing the user with a smooth transition towards context-aware services. Potential application fields can be found in areas such as travel and tourist information, shopping, entertainment, event information and different mobile professions.

Our interviews with potential users and the user evaluations of some of the first location-aware services point out that user expectations are high and that the users in Finland at the time of the evaluations trusted current service providers and policy-makers for issues related to privacy protection. This constitutes a good starting point for location-aware services. It did not occur to most users that they could be located when using location-aware services. This puts additional responsibility on the service providers and policy makers.

Our results highlight the need for comprehensive services, in terms of geographic coverage, breadth (number of services included) and depth (enough information on each individual service). The selection of contents and options should cover the different needs of individual users and the user should be given a realistic description of the coverage of the service. The need for topical information is high: the users can get static information from elsewhere before starting off on their journey. User needs may be related to the past, current or planned location and each user may have personal preferences about what (s)he needs in the different usage situations. The users need seamless service chains that serve them throughout their mobile activity, e.g. planning, searching services, finding the route as well as visiting and storing information.

The evaluation results point out the need for spontaneous and occasional use. The services should be easy to find, and it should be easy to get an overview of the available services as well as their coverage, and services should be easy to take into use and use thereafter.

The willingness of users to be active should not be overestimated. Although the users would benefit from a personalised service, they may not be ready to define a profile separately for each service and each context of use. On the other hand, users may want to participate in the content creation instead of being passive information consumers. Users want to create and store their own location-aware data and they may be willing to share this data with others.

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