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COMBINING LOCATION-AWARE MOBILE PHONE APPLICATIONS AND MULTIMEDIA MESSAGING

JONNA HÄKKILÄ

Nokia Corporation

P.O.Box 300, Yrttipellontie 6, 90230 Oulu, Finland

jonna.hakkila@nokia.com

JANI MÄNTYJÄRVI

VTT Electronics

P.O.Box 1100, 90571 Oulu, Finland

jani.mantyjarvi@vtt.fi

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The quickly emerging usage of multimedia messages offers a new approach for mobile collaboration between users and services by providing a mature and easily accessible technology. This article presents a model for combining multimedia messaging, location awareness of a mobile phone and phone applications, and presents a study of users' experiences when they receive the functionality by multimedia message. The results show that the visual information provided in MM messages was perceived to support orientation in the current location and it was considered important. The results also show that social acceptance of the location-aware multimedia message attached application functionality varies between different message categories, favoring user control and personal filtering. It is suggested that the distinct information elements to be considered carefully in technical implementation and in user interface design include sharing and access right management. Particular attention must be paid to designing a categorization system, which is required for successful information filtering and for user interface design. The categorization system must be either commonly agreed or highly customizable.[*]

Key words: Multimedia messaging, mobile communication, location, context-awareness, mobile applications

1 Introduction

Mobile phones have become an integrated part of our everyday life. In addition to conventional voice calls, messaging is a strongly represented communication mode with mobile phones [15, 10]. The highly adopted short messaging service (SMS), the so-called text messaging, is a common interaction method among various user groups, especially teenagers, who use messaging not only for chatting, but also to coordinate media and times to interact, revise and adjust arrangements [9]. SMS has recently been accompanied by multimedia messaging service (MMS), which offers an easily accessible technology for exchanging pictorial and auditory information between mobile phone users and different services.

[*] This article is an extended version of the paper: Häkkilä, J., Mäntyjärvi, J.,User experiences on combining location sensitive mobile phone applications and multimedia messaging, In International Conference on Mobile and Ubiquitous Multimedia, Maryland USA (MUM), 2004, pp. 179–185

Exchanging pictures online creates new forms of mobile data and collaboration between mobile device users. So far, the research concerning user behavior and potential applications related to multimedia messaging has been negligible. As the MMS technology is still in the early adaptation phase, the ways users utilize it in mobile communication are still finding their form. Research indicates that multimedia (MM) messages are used in various types of communications between people [14] and to enable novel applications, which include, e.g., tagging MM documents with location information during document creation [22], and expressive messaging using avatar animations [18]. Mobile technology capable of pictorial information exchange has been found to hold potential for a youngster's collaboration during activities, for instance in story telling and adventure gaming [5].

In this article, we propose a novel type of MM message functionality achieved by combining MMS technology, online location awareness of mobile phones, and a selection of central mobile phone applications. Receiving a novel type of MM message in a location-aware manner enhanced with application-specific information may bring up new usability challenges that should be charted, as they have an effect on the success of commercial products. The research presented in this article focuses on gathering and analyzing user experiences of the novel type of MMS functionality. The research is carried out with prototype messages delivered to mobile phones. The results of the user study are used to refine the requirements for technical implementation and for user interface design. In addition, a model for combining location-aware mobile phone applications and multimedia messaging to a novel type of MMS functionality is proposed. Our approach for combining location-aware information with MMS utilizes existing mobile phone network infrastructure and widely spread terminals, i.e. standard mobile phones, and thus it has the potential to reach large end-user groups.

This study is based on our earlier research work that provides background knowledge on model development, user interface development for context-aware applications, and selecting the application categories [16, 11, 13]. The organization of the paper is the following: background and related work are presented first, while the model for combining MMS technology, online location awareness and mobile applications is explained in Section 3. Section 4 presents the user tests and Section 5 shows the results. Finally, discussion and suggestions for future work are given together with the conclusions.

2 Background

Location-based services are an expected future trend in the field of mobile computing [1, 12]. Research on location-aware mobile devices has introduced a number of studies on applications, such as shopping assistants [2, 17] and guides in city or campus environments [6, 4]. A user's personal data, for instance calendar notes, can be combined with location information and used for location-based messages to the user [7]. E-graffiti introduces an on campus location-aware messaging application where users can create and access location-associated notes, and where the system employs laptop computers and wireless network-based location detection [3]. InfoRadar supports public and group messaging as a PDA application, where the user interface displays location-based messages in a radar type view showing their orientation and distance from the user [19]. Location information can also be used with other types of context information sources, such as time, nearby devices and gestures [8, 13].

Previous research commonly employs specific devices, which are additional gadgets the user has to carry around, or equipment, which are modified specifically for the purpose, for instance a PDA with an additional GPS module. Thus, to be able to use the application, one usually needs to belong to a certain, very limited focus group. Moreover, current technical solutions are typically based on a special infrastructure designed for the use of the specific application, such as a pre-set grid of WLAN or bluetooth access points, which limits the use the application to a strictly confined area. These factors

have limited both the geographic application area and the target users. Current commercial mobile phones are able to determine their own location information, and applications for sharing it exist. Most simply, location detection can be implemented by using the service cell identification codes as location identifiers. More advanced mobile phone positioning is based on assisted GPS, which combines the benefits of service cell-ID and GPS-based positioning approaches.

Information about the current physical distance may provide useful data for, e.g., time management and social navigation. Many of the device features also vary according to the usage situation: mobile phone ringing tone profile setting to silent for meetings and to loud for outdoors represent a common usage case. The user's availability and device status offer important information when interacting with other people. For example, if another person's mobile phone is set to silent, one can reason that the person is unable to have a conversation at that moment. Availability information has been used in context-aware phonebook and context call [20, 21].

MMS has potential to combine the benefits of synchronous and asynchronous communication. When an MM message is received in the certain place, the user is notified about receiving the message. Notification can be set to occur according to her/his personal settings. Thus, (s)he has the opportunity to react immediately. However, delayed reading of the message may not be as crucial for the user as with a text-based message. The pictorial information enhances the possibilities to memorize the connection in the message content, for example, making the place easier to recognize. Typically, a MM message also includes more than pictorial information, for instance text or audio. It can also be accompanied by other information, such as applications that can be tied to the place in which the picture is taken and to an object it represents, as proposed in this paper.

The applications chosen for our study are notification, presence and reminder, as they form a representative group of applications relevant for a mobile terminal user. To be straightforward to employ into everyday usage, the selected applications offer intuitive cases for end-users and have potential for real life applications in large user groups. Previous results concerning context-aware functions for mobile phone applications indicate that reminders and notifications are perceived as functional and valuable from the end-user viewpoint [16]. Here, location sensitivity and applications with MMS information are combined into a novel type of MMS functionality. Integration of the elements is described in a model presented.

3 Model

To examine the user perceptions, more precisely user experiences and acceptance, of a novel type of MMS functionality achieved by combining location-aware mobile phone applications and multimedia messaging, we have created a model. The schematic of our model is presented in figure 1. Development of the model is based on our earlier work, the tool for personalizing mobile context – aware applications, Context Studio [13]. Using the tool, the user can define which applications or phone functions are activated according to specific real world situations which are represented as context attributes in the system.

In the model, user *a* (the sender) explicitly adds the component for the message. The components include related phone application functionality, multimedia document(s), message recipient and the context triggering the message delivery (here, the location). The multimedia documents include, for instance, a picture taken in a certain location describing an object which the application functionality is linked to. The phone applications, the functionality of which is attached to the multimedia message, include presence, reminder and notification. These application types represent potentially useful

location- or context-based applications [23, 24, 16, 7]. After composing the message, the user sends it. The targeted recipient, user *b,* receives the MM message enhanced with application functionality.

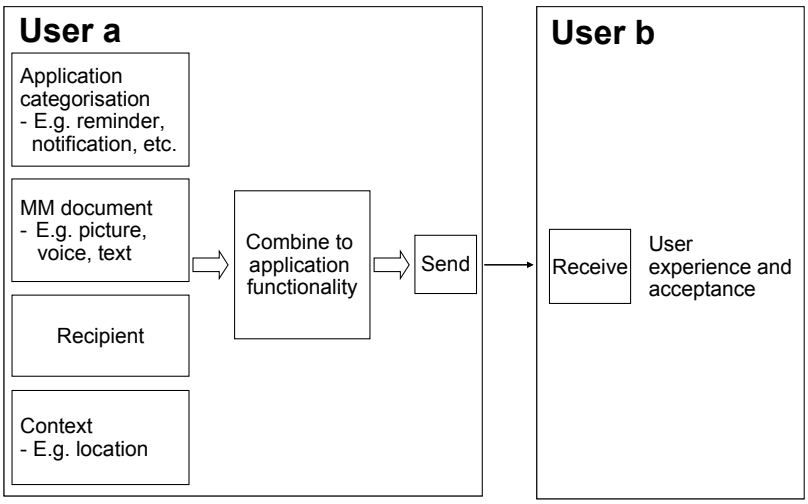

Figure 1 User centric model of location-aware multimedia messaging application

There are various types of information attached to a MM message, including pictorial-, location- and application-specific. User perceptions and reactions when receiving and interpreting such meta information arouse research questions on the acceptability, usability and usefulness of the application. Also, as the proposed concept is a novel one, technical requirements must be gathered in order to enable its implementation in mobile terminals. In our study, the focus is on examining the user experience when receiving such a message and on projecting the results of the technical implementation requirements. Whereas figure 1 describes the model from the users' perspective, i.e., what the users perceive when composing and receiving the message and the component in these actions, figure 2 illustrates a model for technical implementation.

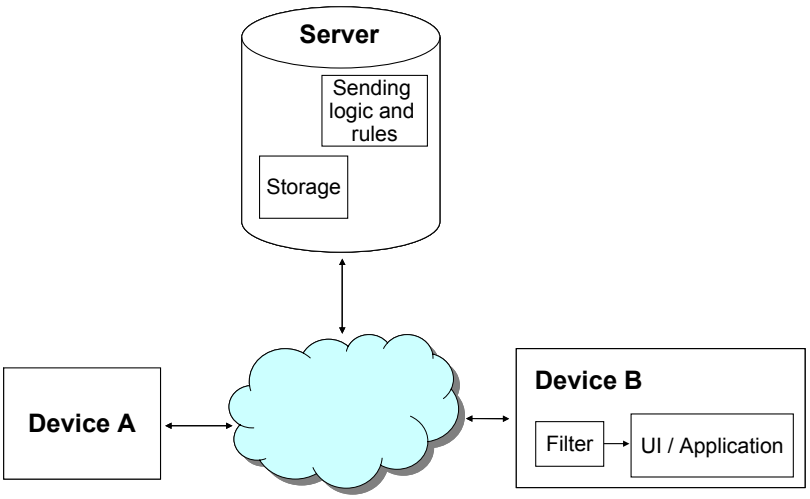

Figure 2 Overview of the architecture for the technical implementation.

Figure 2 presents the architecture for the technical implementation of the application functionality. As a central element the model employs a server, which has two main functions. Firstly, it acts as message content storage, and secondly, it includes the inferring and sending of logic implementing the set of rules defined for each message. These rules can, in addition to location information, include temporal definitions, such as *'message is sent only between 6 and 9 am'*. When a user of device A composes a location-aware message with, for example, a developed tool [13] and sends it, a server receives it first. The server then interprets the elements, i.e. message categorization, recipient(s), and defined context, and maps them with the rules. The message content is saved to the server's storage. When the receiving party, device B, fulfils the context triggers (here, device B arrives at a certain location), the server sends the message to a receiving device (B). Device B includes a filter that enables personalized selections and blocking of unnecessary messages before they are delivered to the device user interface layer. The server is transparent to the users, and thus it is not mentioned in the user-centred model 1 (figure 1).

A server-based implementation has several advantages compared to a point-to-point solution, where only the sending and receiving mobile terminals would be involved. It eases the use of a variety of mobile terminals, as the phones do not have to feature the whole architecture but the property can be realized by using a single (for instance downloadable) application. Also, the computational power required from the end-user terminals is smaller. Updating the system can be done device-independently, which simplifies the maintenance.

4 User Tests

In order to figure out the user perceptions of the application, user tests with prototype messages were conducted.

4.1 Method and Participants

The number of subjects participating in the user test was 9 (3 male, 6 female). The subjects represented different fields of study or work, and they all were mobile phone users. Two of the nine users reported being familiar with the idea of location-based messaging, and in addition three had briefly come across the concept. The test session with each subject lasted 1.5-2 hours.

User tests involved location-aware MMS prototyping within a real life environment, an interview, and a written questionnaire. Tests were conducted at a university campus area, where the subject performed a walk along a predetermined path. Thinking-aloud protocol was used as the subjects were encouraged to voice their perceptions along the walking route where the messages were received. The scenario used for the test was as follows:

You are going to meet your friend Marko at 12:00 in room TS366, as you have to do a seminar presentation together. You have promised to bring transparencies, on which you will print your presentation. You have to buy these on the way. The time is now 11:45. You have a location-aware mobile phone with you.

At the beginning of the interview, the subjects were given a paper sheet with pictures of received messages as a reminder and support for their commentary.

4.2 Test Set-Up

Each subject was given an MMS-capable mobile phone (Nokia Ngage) for receiving messages, figure 3, and during the walk (s)he was accompanied by an observer to whom (s)he could tell his/her perceptions during the experiment. The MM messages were sent by a test organizer for reception at the locations marked on the map, figure 4. Figure 4 illustrates the walking route on the campus area and the MM messages received at each point along the path. The length of the walking route was approximately 1 km. In the following, we use the term "MM message" to refer to the sentence "location-aware MM message with application functionality".

Figure 3 Location-aware reminder received as an MMS.

No.	Category	Function
1	Presence	Notifies of the presence of a contact in the user's phonebook
2	Notification	Commercial information, public information; notification of a current event, located along the walking route
3	Reminder	Personal reminder
4	Notification	Commercial information; public information; notification of a shop, not located along the walking route
5	Notification	Noncommercial information; public information; notification of a current event
6	Notification	Noncommercial information; private note; set by a specific person to be received by a certain person

Table 1. Location-aware messages used in the study

The received MM messages, illustrated in figure 4, were initially categorized by the authors as presence, reminder and notification types, see table 1. Notifications were categorized by their function as commercial and non-commercial information, as well as private and public notes. Contrary to the other messages, message no. 4 was an advertisement for a shop that was out of the sight, not located on but near the walking route. The visual information included in messages 1, 3, 4, and 6 was designed to test if it provided any added value about location to users when interpreting the messages. In message 5, the accompanying image considered the upcoming even, and with message 2, the purpose of the appearance was to focus the user's attention on the advertisement.

5 Results

Results of the user tests were processed from two viewpoints. First, general comments and user acceptance of various message types were examined. User opinions were charted and the most liked and disliked functionalities identified. Second, feedback from the subjects was evaluated in respect to the presented model, i.e., each category and particular characteristics are examined separately. Also, each user's preferences about categorization regarding message types were gathered.

5.1 Most Liked and Disliked Functionality

After the experimental part of the test, subjects were asked to comment on each message and select messages that they especially liked and disliked. The collection of answers is presented in figure 5. The total of the answers exceeds the number of subjects (9) as some subjects selected more than one message for each extreme.

Figure 4 shows that some messages were perceived as strongly positive (messages no. 3, 6) or strongly negative (messages no. 2, 4). Messages 1 and 5 gave rise to mixed comments. Positive feedback indicated that a personal reminder and a private notification were seen as potentially functional and meaningful applications, and they were described as *relevant* and *useful.* Arguments for the personal reminder included *'Useful, right time and right location' (Subject #8)* and *'Relevant, since I have a bad memory' (#6, #9).* Arguments for the private note included e.g. '*It is nice to know that Marko remembers our meeting and will be coming [to the meeting place]'* (#6). Negative feedback indicated that commercial information or public notifications delivered via MM messages were perceived as unnecessary and annoying. They were experienced as 'spamming', and the main concerns related to a flood of overwhelming and uninteresting information and unnecessary interruptions, for instance '*[This is] a spam advertisement. [It is] exhausting to have to check what I just received all the time' (#1),* and *'If every shop sends messages, how can i do anything else but read them?' (#8).*

Messages no. 1 and 5 received both positive and negative comments. Presence information was perceived as useful for social collaboration *'Nice to know if friends are around' (#2)*, but on the other hand it aroused privacy concerns: *'Is my location going to be told to everyone?' (#2)* and *'One has to be able to turn this off' (#1)*. Message 5 included a notification of a current event, and although it was regarded as spam, it was also perceived as more interesting and acceptable than commercial advertisements.

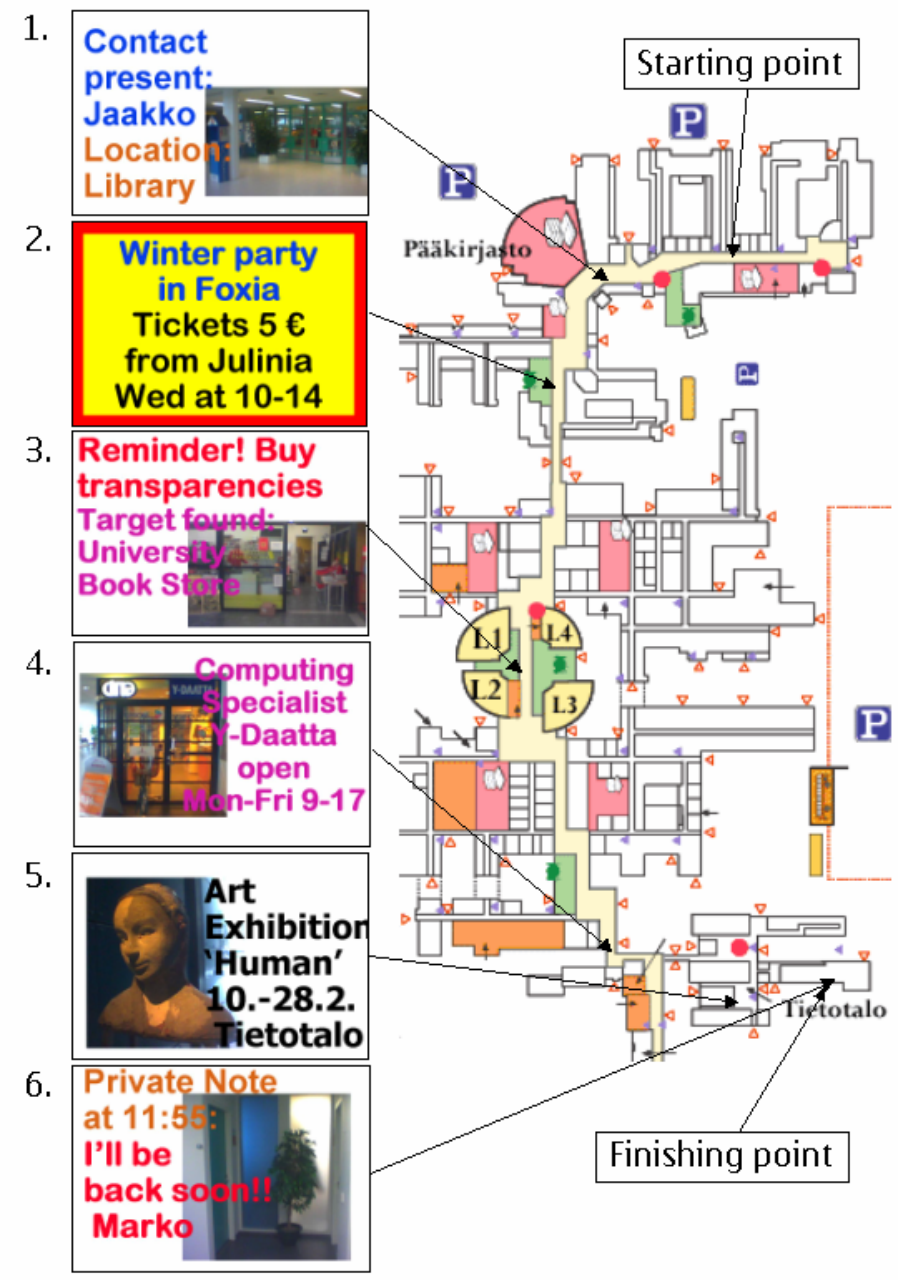

Figure 4 Messages received along the walking route at the university campus area.

The visual information provided in MM messages was perceived to support orientation in the current location that was considered important. It was found particularly useful in confirming the right meeting place (message 6) and establishing the connection between reminder or notification content and the physical environment, as commented in messages 3 and 5. The other perceived benefit was the additional memory support the graphics gave, as the messages could be reviewed later on.

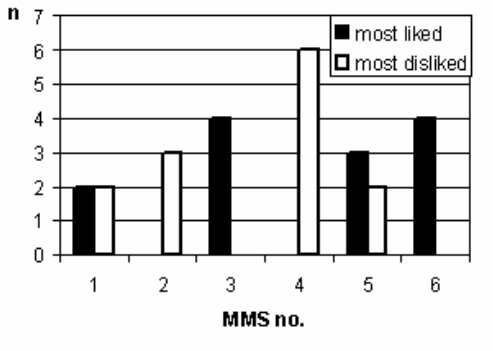

Figure 5 Number of references given for each multimedia message to the question 'Was there a specific message which you especially liked/disliked?'

5.2 Assessing Application Groups: Presence, Reminder, Notification

In the following, the subjects' comments on each message category, *Presence, Reminder* and *Notification,* are grouped.

Presence

The comments mentioned for message 1, i.e. informing the user of Jaakko's presence, are collected into table 2. The most perceptions are related to privacy concerns. Even as the application was generally perceived as a useful functionality, there were immediate questions whether the function is bi-directional, and whom the presence information was shared with.

Table 2. Comments on message 1.

Comments for the Presence message (MMS #1)
Good information. Hopefully Jaakko gets the same message? How far is this scanning? (M1)
Does Jaakko also know that I'm close, or can the messaging work only in one direction? Can I influence who gets my information? (F2)
Most probably I wouldn't give my information to others. (M3)
Annoying. (M4)
This is cruel. (F5)
It might have been irritating if a lot of other contacts nearby had to receive all the messages. Perhaps it would be better to have a choice who to look for. (F6)
Good service, one can use this for occasional meetings. (F7)
I'd like to have it only if I've subscribed to this information or if they have a different sound (alarm / message received sound). (F8)
If you want to read the messages right then, this should be timed at exactly the right position or a little earlier. Depends where the phone is, if [the information] is critical or if the message is useless. Better functionality in a wrist watch or glasses than in a phone – one wouldn't have to dig [the device out] from anywhere. (M9)

The concerns related to system infrastructure and application functionality considered the time and distance range of the application. Timing was perceived critical, as the information usually had value to the user only when received close enough to the other person. This was also influenced by the distance from which the presence notification is given. Another issue was whom the presence

information was shared with. It was highlighted that selection of sharing parties required some kind of trusted or privacy filter, which could be edited by the user. Allowing information sharing by subscribing to the service was also mentioned as a useful feature.

Reminder

Comments on the personal reminder, message 3, are presented in table 3. Reminder functionality was seen as a valuable and usable feature. Questions here related to the reliability of the application: Who knows if the paper shop sells transparencies, or what happens if you forget to go by that specific place. The collaboration aspect was also pointed out when setting reminders for someone else was considered. Reminder type messaging emphasized the role of the sending entity and triggering conditions. Sharing reminders and setting them to others requires access to user-specific information elements in a model (figure 1).

Table 3. Comments on message 3.

Comments for the Reminder message (MMS #3)
Good reminder with location information. How easy is this to set? Maybe only a reminder of the place [would be enough]. (M1)
The reminder is quite good. Do I have to set this up myself, or will 'Marko' set it? It may be irritating if others can remind you too much. The reminder itself is good, but if the shop only advertises itself, that would be annoying as I can see it anyway. On the other hand, if I'm in a new environment, the information might be welcome. Can the ads be filtered, for instance, only the places that I hadn't visited would advertise to me? Is there any limit with investigating consumer behavior? (F2)
If reminders are location-aware, is there a risk that one forgets the place and never get the message or reminder? (F2)
A function that I would found useful. (M3)
Good. The most important [message]. (M4)
Good! (F5)
Very nice to remind me! Who decides that transparencies can be bought in a paper shop? (F6)
Good service for your own use. The bad thing is that you become very dependent on the phone when everything is in its memory. (F7)
Very useful. (F8)

Notification

The comments on notification messages are presented here with the comments of messages 2, 4 and 5 grouped together (table 4), as they received very similar feedback. These messages can be seen as 'public notifications', as they were not directed to any specific user.

Table 4. Comments on messages 2, 4 and 5.

General comments for Public Notification (MMS #2, 4, 5)
Irritating if it comes as a message, [as] one always has to check what has been received. I wouldn't use it, for instance, in a city (spam). (M1: #2, 4, 6)
It would be good to be able to turn the ads 'off'. See [my] answer for Message 3. (F2)
I wouldn't want it on my phone. (M3: #2, 5)
Annoying. (M4: #2, 4)
Personalization would work better so that not all ads would come (about anything). (F6: #2, 5)
Good service, but one should be able to restrict what kind of notifications one wants to receive. (F7: #2, 5)
Same as message 1: I'd like to have it only if I've subscribed to this information or if they have a different sound (alarm

/ message received sound). (F8: #2, 4.)
Specific comments for MMS #2:
The message was late! Also, [it] should be received only at the specific time (Wednesday between 10-14 o'clock) or earlier. (M9)
How much in advance do these messages come? Is the same message coming every time I pass the place? (F2)
Specific comments for MMS #4:
This could be handy if the information search was done in an active manner. (M3)
This would work well if I was looking for a [new] TV, I could set a search 'find TV shops'. The phone would then notify me when such a shop was nearby (for instance in a foreign city). (F7)
Specific comments for MMS #5:
How about copyright [with this type of messaging]? (M1)
When and where [is this exhibition]? Is this really going to be on? (M9)

Message 6 can be treated as 'private notification' as it was directed to the subjects and not meant to be received by anyone else. Comments on message 6 are gathered into table 5.

Table 5. Comments on message 6.

Comments for Private Notification (MMS #6)
Good information. On the other hand, this would have been done previously by [sending] a [text] message. (M1)
Can I get in contact with Marko if needed? Do I get the message if my phone is not turned on? What is the delay? Good, if I can ask information about Marko's location. On the other hand, it is oppressive if someone could get my own information. (F2)
Interesting application. (M3)
Good. (M4)
Good service. A quick and comfortable way to inform about small changes in plans. (F7)
Very useful. (M8)

Messages in the notification category led to a lot of doubts and criticism. The subjects who were ready to receive notifications only accepted it conditionally, as they wanted to be able to select the types of messages they would receive. Spamming with unnecessary advertisements and the flood of information were common concerns, and filtering was suggested to prevent undesired messaging. There were no differences in comments referring to the distance if the message sender was within sight of the user. User perceptions of acceptability and usefulness were significantly more positive with private notifications than with public notifications. The role of the location as a trigger was emphasized, as the message was important only if the user entered the specific location. Otherwise, receiving the message was not compulsory. This feature is contrary to a location-aware reminder, as reminders for their functionality must go on at some point even though the location trigger would not match.

Categorization for Perceived Messages

The subjects' perceptions of different message classes were evaluated with the question *'How would you categorize the previous messages?'*. The most typical way of categorizing messages was to distinguish who had sent the message. The categorization based on the following classes was done by 7 of the 9 subjects (subjects no. 1, 3, 4, 5, 6, 7, 9):

- *Own, self-set messages*

- *Messages initiated by a friend or equivalent*
- *Advertisements*

Within these answers and the category 'Advertisements', three subjects (5, 6, 7) distinguished two subclasses, 'Advertisements' and 'Current events'. Subject F2 proposed two ways of categorizing the messages:

- *Public / Private*

or

- *Entertainment / Benefits / Personal.*

Subject F8 combined the focus audience and temporal factors dividing the messages as follows:

- *Things which are useful for me personally right now*
- *Messages for me personally, but not necessarily now*
- *Messages for everybody who is nearby*

An interesting detail in the answers was that when the subjects mentioned messages containing the location information of a friend (message #1), these type of messages were described as general location notifications, i.e. not for indicating presence or proximity. Another interesting detail was that users perceived various categorizations. This reflects that UI design should consider an interface with customizable functionality.

6 Discussion

The results of the user tests are discussed in two parts. First, in-depth discussion of their interpretation is provided. Second, the implications of the results on the requirements regarding technical implementation and UI are discussed.

6.1 User Perceptions

Generally, the subjects' perceptions of location-aware messaging were quite consistent. Privacy concerns were dominant when subjects presented their negative reactions to location-aware messages with presence indicators. The potential flood of information and unnecessary advertising led to criticism, especially with public notification messages. These results are consistent with previous research [11].

Pictorial information included in MM messages was perceived as useful, since it helped users to orientate themselves in the physical environment and connected the message content to the physical surroundings. It was also seen as memory support, because the message could be reviewed afterwards.

The authors' proposed categorization of reminder, notification and presence was slightly different to what the subjects perceived. The dominant argument for the categorization suggested by the subjects was to classify messages according to the message initiator: user, friends or equivalent, and an advertising entity. There was also a tendency to distinguish between subcategories like advertising shops and enterprises versus current events even if they were both commercial notifications. The message informing the subject of the proximity of a friend was perceived as a general location indicator rather than just a remote presence notification. This means that the user expressed their willingness to be informed *where (in further distance)* their friend was instead of just getting a

notification of him/her being *close by*. There was also a trend to categorize the messages as private and public according to their focused receiver.

6.2 Refining the Requirements

The message classification by users is coherent and indicates that people have a strong sense of the different functions of the messages. As interpreted from the results, the message categories have differentiating priorities, and the acceptability of them varies. These issues help us in developing interaction and user interface design, for instance the interaction flow, menu structures and provided settings and options.

The characteristics of each message category can be taken into account when considering them in respect to the model, and critical points can be found. Thus, the model can provide guidance, for example, in the application design phase, as special care can be devoted to specific parts of the application interaction design. The following findings can be derived from the user test results. When evaluated in respect to the presented model, the contextual triggers for reminders were found to be critical. Presence applications would also require both parties to agree on the information sharing in order to ensure the privacy of individuals. With public notifications, the target group needs to be especially considered in order to avoid unnecessary and irritating spamming.

Location-based messaging can be implemented either as a pull- or push-based system, which also sets specific requirements for the application design. Pull type messaging, where the user makes a request to gain information, reduces the amount of unnecessary messaging, but on the other hand demands active actions from the user and thus requires more effort. The former suits is better suited for 'search information' rather than 'notify of present information' type actions.

Reliability needs to be considered in application design and it is emphasized in situations where the proper functionality of an application is needed even without location-aware information. For instance, the reminder should still go off at some stage, even if the location is not optimal.

The requirements the notification application category sets for the infrastructure and service must be carefully considered, as potential risks exist, e.g. to implement disturbing functions. One important result is that filtering needs to be employed, and successful implementation requires consistent and commonly accepted categorization of services and enterprises. Furthermore, introducing a search function requires a database of available services and commonly agreed vocabulary with which the services can be mapped to the user's profile or personal needs. Simple usage UIs are required to (un-)subscribe to public and private services, and edit filtering and functionality.

Multimedia messaging offers a functional and accessible platform for location-aware messaging. Since it is featured by ordinary mobile phones, it has a ready-made infrastructure and a very large number of potential users. The models proposed in figure 1 and 2 offer a straightforward way of implementing a location-aware MMS application. However, implementing this kind of architecture would require some general, commonly agreed elements in order to ensure enhanced usability according to the experiences gained from the user study. A commonly agreed categorization should be employed in order to enable targeting the messages to certain focus groups and to make efficient filtering possible.

7 Conclusions

Multimedia messaging service (MMS) has recently been introduced to a wide audience of mobile phone users, and it enables the development of new application concepts and mobile services. In this study, we have explored user experiences of combining location-aware mobile phone applications and multimedia messaging to a novel type of MMS functionality. The selected message types under investigation were presence, reminder, and notification (public and private), which were selected because they were seen to provide a representative sample of potentially useful and realistic location-related messaging applications. The purpose of the research in this paper was two-fold. First, we have presented a simple model, which defines the elements for composing multimedia message enabled location-based application functionality. Second, the users' perceptions of location-aware multimedia messaging were investigated with user tests. The user perceptions were used in refining requirements for technical implementation.

Reminders, which are activated in certain contextual conditions, here by location, were perceived as the most useful application and gained high acceptance, although they also caused concerns related to the inferring logic concerning which conditions the reminder was to be triggered in. Messages informing the user of another person's presence were felt to be practical and fun, although these opinions were mixed with concerns of privacy. Private notes set by a certain person targeting a specific user were considered useful, and value was particularly seen in social cooperation situations when rapid changes in plans occur. The main concerns with the location-aware applications were unnecessary advertisement and privacy threads. The subjects also valued the opportunity to profile and filter messages. The subjects' perceptions of message categories followed the message initiator, as the classes were most commonly divided as follows: the user him/herself; friend or equivalent; and an advertising entity.

When examining the results in respect to the model including elements for multimedia message enabled location-based application functionality, it was found that different message categories emphasize different elements of the model. This can be considered useful information for the application and UI design process.

Since there is clearly is a need for filtering and profiling the messages, there is also a need for a commonly agreed highly customizable categorization for different message types. Collaborative distributed mobile data management is also needed in order to enable seamless cooperation between the service providers, operators, and application developers. In addition, there is a need to manage the information sharing and access rights for distinct information types. For example, this is required with mobile collaboration tasks, writing private and public location-specific notes, and sharing presence information with other users.

The next research steps include refining the proposed model and more extensive user testing on the topic. Implementing a prototype with the technical features implemented would provide more usability information, and will considered for future work.

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