Social Acceptance and Usage Experiences from a Mobile Location-Aware Service Environment

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Abstract. MUGGES is a European research project with the goal of evaluating peer-to-peer service concepts based on GNSS systems for mobile phones. MUGGES provides an infrastructure to create, publish, provide and consume mobile micro-services directly from mobile devices. As part of the project four application prototypes have been developed, which allow for the description and sharing of places and routes between users. This paper reports about a user trial conducted in real environments with early adopters. The goal has been to identify benefits and best practices for the type of applications envisioned in the MUGGES project. The obtained results indicate that users like to share information about preferred places or routes, and see it as a complementary application to already existing applications such as Facebook or Twitter. These types of applications are often used in time-killing situations, e.g. at the bus stop. Their value lies on the highlighting of important places or non-everyday events, and on making daily coordinations simpler. People feel that the application is less intrusive, since no information such as the whereabouts of persons are shared anyhow.

Key words: Prosumer concept, peer-to-peer, semantic location model, micro-services, user trial

1 Introduction

Social services such as Facebook, YouTube or Twitter have empowered users by making them not only consumers of information but also producers. This trend is now moving to mobile social services, which offer a more natural way of social interaction – anywhere at any time from the user's mobile device. Interestingly, most current mobile devices incorporate Global Navigation Satellite Systems (GNSS) technology such as GPS, thus making location-based mobile social services a very clear current trend of business innovation. This is due to the fact that location is considered a key context attribute for more optimal service filtering and recommendation in mobile domains [1, 2].

The MUGGES project (Mobile User Generated Geo Services, [3]), funded by the European Commission's 7th Framework Programme [4], goes one step beyond current mobile location-based services (LBS) by providing such location-aware services and their contents directly from the user's mobile device, i.e. the mobile device evolves to be a server. Thus, mobile users turn into location-aware service super-prosumers, i.e. producers, providers, and consumers of services and associated contents from their mobile devices. Besides, this project also focuses on the development and real-world testing of a new and sophisticated heterogeneous location model which combines GNSS-based positioning and user-provided social positioning.

This paper deals with on the analysis of the information gathered from the testing of the MUGGES concept through a trial. The main objective of the user trials is to analyze how the prosumer concept is accepted, the feasibility of mobile peer-to-peer approach and the benefits for mobile location-based micro-services. The structure of the paper is divided into two main parts. The first part (Section 2) defines the MUGGES system by providing an explanation of the key topics behind this project: the super-prosumer role of users, the MUGGES location-aware services, the peer-to-peer architecture and the location management. The second part of the document (Section 3) describes the trial held in Finland, tackling the planning and the first experiences collected from the assessment of the information gathered therein.

2 The MUGGES System

The rationale behind the MUGGES project is to demonstrate that there is significant market potential for location-based services in Europe, and that the technology associated to this kind of services is currently mature enough to deliver real benefits to users. The main challenge of MUGGES is to find a new perspective to introduce massive mobile applications focused on mobile users' instant needs and interests, i.e. user- generated services, where the location is the enabling feature.

So far location has been exploited in the mobile environment mainly as a key service enabler for personal usage in client-server schemes, e.g. navigation, guidance and tourism. The underlying idea beneath MUGGES is to provide users of mobile devices the right tools that allow them to create focused, knowledge-based, mobile location-based micro-services *on the go*, converting the mobile device not only into a "player", but also into a "server".

In this context mobile users are not just seen as mere passive consumers of contents, but they are actively involved in the process of producing, creating and distributing location-based services and contents from their own mobile devices. Therefore, users in MUGGES are considered *super-prosumers*. By super-prosumer, we understand that users act as providers, producers and consumers of micro-services by using only the mobile device. In other words, prosumers provide contents directly from their mobile devices (or other user-owned electronic

devices), where these contents are stored, and thus transforming the mobile device into a server. Within MUGGES these micro-services are called *Mugglets*; they are small and independent location-based social services hosted in the mobile terminal and provided from the mobile terminal to a distant mobile device.

2.1 Location-Aware Micro-Services in MUGGES

Before delving into the roots of the MUGGES system, let us first elaborate on the application of the MUGGES project to a short real-world example by commenting on one specific Mugglet, the "MUGGES Note":

Bob is visiting Lisbon's most traditional nightspot, Barrio Alto. After wandering around the streets for some time, he decides he may need some advices on the best spots. He takes his mobile phone and searches for MUGGES Note on the MUGGES Mugglet Search Engine. Shortly thereafter, he is looking at a list of notes posted around his current location and decides to check out "Maria Caxuxa" on the "Rua da Barroca", where people seem to be having a lot of fun! When he reaches the bar, he posts a photo of himself showing off how much fun he is having. This photo is now accessible by all the MUGGES Note users walking by and maybe attracts them to join Bob at the bar.

This example illustrates the benefits of attaching a location attribute to notes, achieving an improved integration between the physical and digital world. In order to demonstrate that 1) there is significant market potential for location-based services in Europe, and 2) that the LBS technology is mature enough to deliver real benefits to the users, we have implemented more complex micro-services which represent groupings of MUGGES notes. Specifically, the following four Mugglets have been designed and experimented by real users:

- "MUGGES Note": This Mugglet allows publishing short messages with a photo and attaching it to a specific location. Other users can then retrieve these messages at this location (see Figures 1.a and 1.b).
- "MUGGES Journal": The main goal of this Mugglet is to maintain a journal bound to the current position of the user. This Mugglet represents a set of semantically-related MUGGES notes maintained by a single author and ordered by date. Each note has its own location (See Figure 1.c).
- "MUGGES Trail": This Mugglet is an application which allows users to define routes with information about the places on them by adding a sequence of MUGGES notes (i.e. a starting point, intermediate points and a goal). This kind of Mugglet permits users to see the directions from their current location to the next point on the route, with the aim of guiding them to the end of the route without any trouble (See Figure 1.d).
- "MUGGES Race": This Mugglet is made for runners allowing them to follow a predefined route and compete with others in an asynchronic manner. Users must reach specific checkpoints to get to the goal and complete the race. The total time is measured and recorded by the service (See Figure 1.e). In the case of this Mugglet, each point of the race is considered and implemented as a MUGGES note.

(a) (b) (c) (d) (e)

Fig. 1. MUGGES application interfaces: a) MUGGES Note. b) MUGGES Note photo view. c) MUGGES Journal. d) MUGGES Trail. e) MUGGES Race.

2.2 MUGGES Peer-to-Peer Architecture

As depicted in Figure 2, the MUGGES platform is modeled as a triangle where there is no central service provider, only the service infrastructure that facilitates connections between producers and consumers. The process is as follows: the service provider creates the service and publishes it through the service infrastructure. A Mugglet published through the service infrastructure can be searched and found by other Mugglet users. To consume a Mugglet, users have to query the server infrastructure. After downloading and installing the Mugglet on their device, users can execute the Mugglet. Communication is then handled directly between the Mugglet provider and consumer. Such peer-to-peer architectures have several advantages for the user:

– Service provision can be done instantly, without need for cumbersome uploads to an intermediate internet platform.
– Users maintain always full control over their services and can withdraw them at anytime.

MUGGES provides two mobile applications to manage Mugglets on the mobile phone: 1) the "creation kit", which is used to guide the user through the creation process and make Mugglet creation as convenient as possible for the user; and 2) the "execution platform", which manages Mugglet installations and provides access to mobile phone capabilities such as the embedded GPS or camera systems. On the server side, different software components ensure the correct functionality of the MUGGES system: on one hand, the service infrastructure hosts a storage system for the Mugglets and related templates. It allows users to search them based on keywords, template category and location. Since mobile devices may use different positioning technologies, a location manager part of the service infrastructure supports the translation between different location concepts. On the other hand, the user management and accounting component

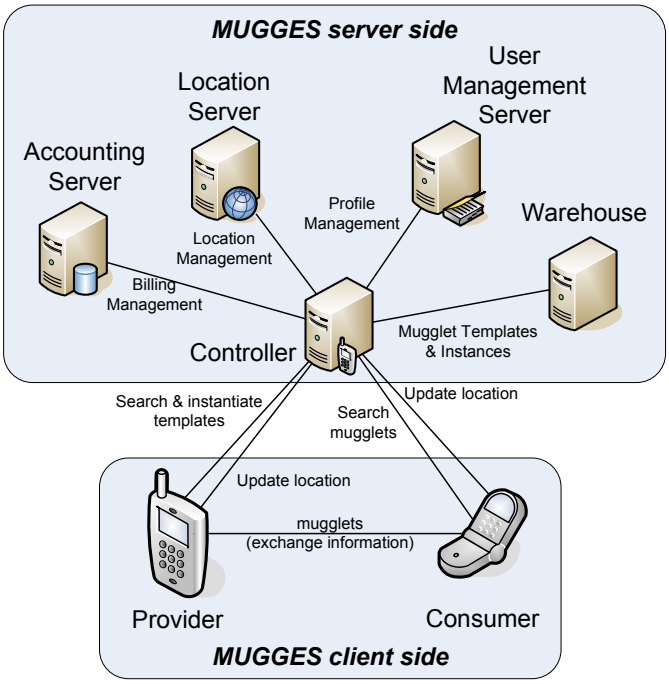

Fig. 2. The prosumer triangle.

of the server infrastructure provides user and community profile management functions, and also records information required for billing purposes.

2.3 Location Management in MUGGES

Mugglets are bound to the physical world through location descriptions. Consequently, location descriptions become a crucial filter to search and access Mugglets. Managing locations can be complicated due to heterogeneous location technologies and different interpretations by humans. Different systems exist for indoor and outdoor positioning. Well-known indoor position systems are visual markers, Wi-Fi or Bluetooth based systems. Visual marker technologies translate symbols in locations, whereas Wi-Fi and Bluetooth positioning are based on triangulation, a methodology which calculates the position from different signal strengths issued by senders placed in the environment. For outdoor positioning the most commonly used system is GPS. GPS expresses locations through coordinates in latitude, longitude and altitude, e.g. in the World Geodetic System [5]. For instance, the city of Bilbao is located at latitude 4315'25", longitude -255'24" and altitude 19 m.

The Location Server (LS) component of the service infrastructure hides the underlying technology used to determine the user's location. This may be anything from a GNSS receiver's coordinates, to the phone's Cell-ID, the surround-

ing Wi-Fi base stations, a RFID reader, 2-dimensional barcodes or even plain text. For the verification of this location management concept we implemented GPS and Cell-ID for outdoor positioning and visual markers as indoor positioning system. It is the LSs responsibility to identify the correct position based on one or a combination of these pieces of location information. The significant advantage of this approach is a stronger independence of heterogeneous location technologies, and makes the MUGGES system well suited for a wider range of usage scenarios.

As opposed to machines, people use conceptual language to represent location data. In other words, while computers use numbers, people use concepts (e.g. "near the station", "at the museum", "in the market area"). Hence, in MUGGES location-based services are accommodated to the way people need to utilize them, and correctly interpret expressions at a semantic level, just as humans do. Location information is represented and used in a humanized way. Therefore, the Location Server distinguishes between physical, symbolic and semantic locations. In MUGGES users collaboratively create, maintain and constantly update a coherent location model based on their collective contributions. Besides the location server seeks the help from external location mapping or modeling services such as GeoNames [6] or Google Maps [7].

3 MUGGES Trial and Evaluation

3.1 MUGGES Finnish Trial Setup

A functional and technical evaluation of the MUGGES system was carried out through user trials hosted in Espoo, Finland. This trial was conducted based on the Living Lab concept requiring and seeking high involvement of the users in real usage setups. MUGGES services were provided from a server installed and operated in Spain. The trial itself was held in one single phase of two weeks, one indoor and outdoor trial aiming to test heterogeneous location mechanisms for LBS applications. The base scenario consisted of:

- 8 users equipped with advanced mobile phones powered by MUGGES components and a GNSS receiver.
- 10 hot areas for interaction limited by geographic coordinates.
- 4 deployed social LBS applications that promote location-based interactions among different user types.

The trial was held close to VTT headquarters, mainly in a roughly 1 km^2 area within the Otaniemi technology campus. VTT's technical campus was furnished with symbolic locations with the help of the MUGGES location model. Trial users, however, were not restricted to experiment with the application in the main trial area, but encouraged to test the application elsewhere as well, in order to gain as much information as possible regarding the technical and operational evaluation of the system.

Regarding the recruited group, 8 IT professionals – aging from 26 to 53 years and working at VTT – were recruited. This sample group represented a group of critical, tech-savvy early adopters (enthusiastic to try new technologies). For that reason, the results of the trial cannot be identified with a layman's view on MUGGES experience. Since the trial has been held in the heart of winter, weather conditions in Finland turned out to be very demanding for testing any mobile application. The temperature was continuously below 0°C, leading to frequent heavy snowfalls (see Figure 3). Harsh conditions highlighted not only the requirements for usability, but also to fit to the context [8].

Fig. 3. Weather conditions rose exceptional challenges for mobile service use.

For the trial, users were given Nokia 5800 XpressMusic touch screen smart phones with pre-installed and preconfigured MUGGES software. All the utilized phones have a small touch screen, embedded GPS and a prepaid 3G/3.5G data connectivity that allowed 0.4-6 Mbit/s downlink data transfer. Tests before the trial revealed several shortcomings of the phones and MUGGES software: the application was not easy to use due to touch screen problems, the upload bandwidth represented a bottleneck for the peer-to-peer messaging and the runtime memory was too small and slowed down the application over time or even crashed occasionally. The trial was started with a 2-hour kick-off introduction to MUGGES concepts and the functionality of the application. This intensive training session was used besides explaining the MUGGES user interface to teach trial participants to deal with the technical problems described above.

3.2 Assessment of Trial Results

Based on obtained data during the trial we analyzed MUGGES usage and its workflow. People used Mugglets over a period of two weeks. Mugglet usage was the highest in the initial days of the trial and dropped slightly in the remaining time. During weekends MUGGES was usually not used, since technical support was not available. The drop of the usage rate during the week can be explained by the bad weather conditions in Finland (heavy snowfall). Besides the weather, trial users mentioned distractions through the environment and the unstable implementation as the biggest and major reasons to dismiss the usage of MUGGES. Such reasons are graphically shown in Figure 4.b. Based on an interview performed at the end of the trial, it is inferred that most of the trial users would use Mugglets once a day (see Figure 4.a). This can be deemed as a value lying in the range of similar third-party applications.

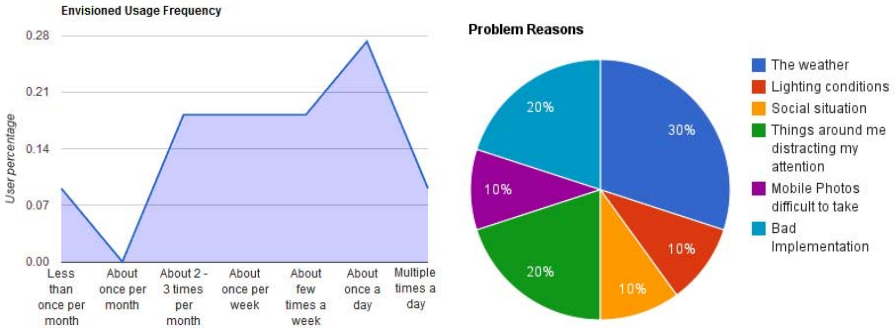

Fig. 4. a) Mugglet usage prediction; b) envisioned distractions for not using MUGGES.

In the following we take a closer look on the Finnish trial results as examples of spatial distribution of the occurrences of MUGGES activities, as well as we discuss the findings and related experiments from trial conducted in Finland. In the spatial examination, we concentrate on the following three basic MUGGES tasks: creation of Mugglets, provision of existing Mugglet and consumption of Mugglets, i.e. downloads of Mugglets from another user. Execution of each task by the trial user created an event with the location, which enabled us to visualize the MUGGES activities of trial users on maps. In Figure 5 occurrences of each task type are visualized on a pair of maps. The first map in the pair renders a view on the area of interest in larger geographical scale, while the second one zooms into the Otaniemi campus, which was the main trial area. Task occurrences are represented as circles of different yet proportional sizes in the maps, in the sense that the more events bound to the same location there are, the bigger the circle representing the number of events in that location is.

• **Creation of Mugglets:** During the Finnish trial a total of 149 Mugglets were created (published) and most of them (84 %) were basic MUGGES Note Mugglets. The proportions of mash-up Mugglets from all created Mugglets were: MUGGES Journal 7%, MUGGES Trail 6%, and MUGGES Race 3%. The small proportion of mash-up Mugglets is understandable since they acted as special-purpose containers of already existing Note Mugglets. Even though the sample of trial users and number of created Mugglets were small, clear hints of participation inequality (the 90-9-1 rule for lurkers and contributors [9]) can be observed in the Finnish trial where one of the trial users created 60% of all Mugglets. In summary, This rule means that "In most online communities, 90% of users are lurkers who never contribute, 9% of users contribute a little, and 1% of users account for almost all the action".

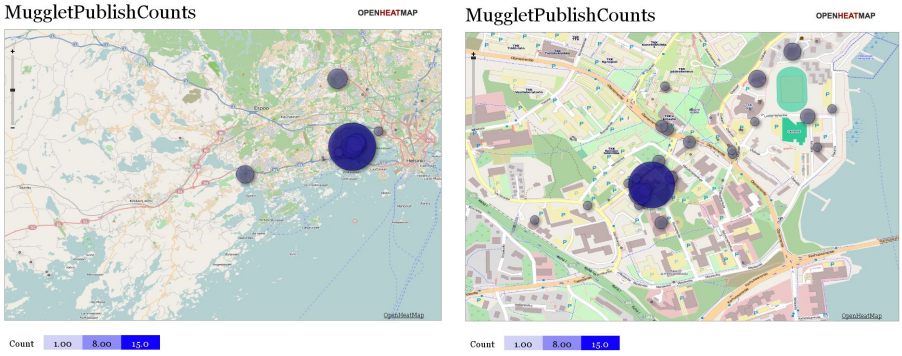

Fig. 5. Spatial distribution of Mugglet creation locations.

As the left-hand side map in Figure 5 shows, Mugglets were mainly created in the Otaniemi campus area according to the initial trial assignment and due to the fact that trial participants were working in that area. Other publishing places were related mostly to users' home locations and some outdoor locations related to the leisure time activities of trial users (the trial coordinators encouraged users to test Mugglets at their leisure time as well). The right-hand side map in Figure 5 elucidates that the main publishing activity was centralized in the VTT Digitalo premises and its surroundings, including the student society building and its popular student restaurant (the Otahalli sports center) where trial users had their activities. In VTT Digitalo, QRCodes located conveniently near the coffee rooms were often used to bind the Mugglets to the location. As the users used often two-phase workflow for creating and finalizing Mugglets, there was a clear need for providing private workspace for Mugglet creation, where users are able to keep their Mugglets as long as they are finalized and ready for publishing for others.

• **Providing Mugglets:** Regarding the provision of Mugglets, it was detected and reported that mobile devices became slower over time due to the instability of the MUGGES system. By thoroughly analyzing this phenomenon we discovered a strong correlation of the provided Mugglets and the execution speed. In a range up to 30 Mugglets per phone the execution speed was so slow that some people started to uninstall their Mugglets again. We also discovered that no more than 5 MUGGES consumers could access the same Mugglet at the same time. The reason may lie on the asymmetric upload and download bandwidth of the installed connection, which is counterproductive for the peer-to-peer concept of MUGGES. Regarding the provider-consumer ratio per Mugglet, it was seen that most Mugglets were intended for smaller groups, but some were targeted for larger audiences (i.e. up to 8 people). Since the size of the test group was 8 people, we assume that they tried to address the general public.

The peer-to-peer approach in MUGGES architecture gave rise to several technical challenges. When the user decided to either close the MUGGES application or to switch his/her phone off, the provided content disappeared from the other terminals, which was considered as a major drawback of the proposed solution. For the same reason, the searches made by the trial user often led to problems when providers closed MUGGES applications and old search results referring to the disappeared Mugglets still remained within the search results (if user did not made a re-search). Fortunately, this drawback can be solved by forcing a timed refresh of the search engine upon disconnection of a certain MUGGES user.

• **Discovery and consumption of Mugglets**: In total over 300 consumption events (i.e. the download of a given Mugglet from a peer) were logged in total during the Finnish trial. According to the compiled data, the MUGGES system was mainly utilized daily during the working hours (from 8 a.m. to 5 p.m.). The main activity gravitated on the Otaniemi campus area, but some users also examined Mugglets in their home locations outside Otaniemi. In the latter case, consumption took place also during weekends, as well as at times beyond working hours. Most of the consumption in the Otaniemi trial area was accumulated inside the VTT Digitalo premises (indoors), where users experienced with the MUGGES application during the coffee and other breaks along their work schedules. Other popular locations for consumption included the surroundings of the student society house, library and bus stops. It is remarkable that consumption of Mugglets was accumulated in indoor locations where working with mobile device was the most convenient choice. In addition, and as expected, also "dead-time" moments offered opportunities for Mugglet consumption, e.g. during the waiting time at the bus stop, or while waiting on something or someone at a public place.

Mugglets were consumed often in locations that were different from the Mugglet location. This result states that current MUGGES applications were not strongly location-aware, but just location-based applications. This result is further explained by the fact that Mugglets were searched primarily through other than location-based means (keyword and category searches). Furthermore,

proactive features (e.g. those that notify users when some interesting contents are nearby the user's location) were missing from the current MUGGES implementation.

3.3 Frequently Requested Features

After the field trials, users were asked about the features they missed most during the trial. The following aspects were mentioned repeatedly:

- In order to increase the transparency of the MUGGES community, users requested the enhancement of MUGGES with social features such as Mugglet recommendations and ratings. In addition, they suggested incorporating, to the Mugglet creation procedure, the option to address specific groups of friends for their Mugglets, e.g. by extracting the contact list from the Facebook account of the Mugglet creator. Not all of the created Mugglets were intended for the public usage.
- Users also claimed that the process of creating a Mugglet is a strong effort, and consequently they are willing to get feedback from the consumers of their created Mugglets. From the consumer point of view, recommendations allow for easily distinguishing popular and important Mugglets from others, a feature which in the long run increases the value of the offered Mugglets.
- Another frequently requested property was the real-time administration of Mugglets, e.g. by notifying MUGGES users about new comments or notifications of the Mugglet itself. Some users also wanted to interact with their Mugglet provider through direct chat tools.

4 Concluding Remarks

Mugges opens new opportunities for people to create mobile micro services and share them with others. The trial conducted in Finland revealed interesting results: first, trial users found it appealing to furnish real-world locations with their own digital content. Trial users perceived the concept of mash-up Mugglets as very powerful and suggested to extend the concept by allowing the re-usage of notes from others. The creation process for Mugglets with wizards was seen as ineffective. Note Mugglets were almost always containing a photo, which emphasizes the importance of multimedia as mobile content.

Users also raised issues that were related to the discovery and search procedures of Mugglets. Especially when the number of Mugglets increases, users felt that simple Mugglet retrieval lists were not useful and better ways of grouping, sorting and restricting of search results were needed. In comparison to existing commercial products, MUGGES can be seen as a complementary offer. Facebook, Twitter and Foursquare are more concerned about social networks, and less about the physical environment. It is important to note that users are worried about their privacy, and would hence prefer to share information about their favorite places and routes instead of publishing their current position. Based on

this observation, the possibility to control the content was seen as very positive. This is buttressed by the fact that people envision to use it quite frequently – at least once per day – preferable in typical time-killing situations such as bus stops. However, one user remarked that there is a potential threat if the MUGGES application is hacked and outsiders may get access to personal information on the phone. Further research will be conducted to circumvent this issue.

This paper summarizes the results obtained from the Finnish trial. Taking into account these results and the comments made by the trial users, new functionalities and improvements in the MUGGES system will be included and further tested by users in the future through new trials.

Acknowledgments

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