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Spiderweb: A Social Mobile Network

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***Abstract*—Social networking sites obtained a great success in the last years. Their popularity is related to changing lifestyles, where people increasingly look for new acquaintances or cultivate old friendships by means of the Internet, typically using a PC. Yet along with the rapidly increasing amount of mobile phone users, as well as the development of so-called smart phones, the possibility for creating similar services for mobiles arises. Importantly, the mobile phones are not just entry points to existing social networks with their centralized architectures; being mobile offers one more degree of freedom. However, mobile social network services are unquestionably limited by mobile phones weaknesses (e.g. small screen, keyboards), so several challenges are necessary to be addressed. Consequently, in this paper we analyze usability and user satisfaction of mobile social networks. Thus, a mobile social network application called Spiderweb is implemented and used as a test case. Spiderweb provides to the users an opportunity to make acquaintances, search for people on the basis of certain criteria, chat, view profiles of other users, and with numerous other possibilities. Yet the application not only offers the mobile phone users services similar to social networks available on the web. Spiderweb moves beyond this concept, also giving an opportunity to interact with other users through Bluetooth connectivity. Thus, the application enables establishment of spontaneous collaborative networks which are further explored and evaluated in this paper.**

***Index Terms*—Mobile social networks, Global Positioning System (GPS), Bluetooth, Peer to Peer (P2P), Mobile application usability, Virtual Life**

I. Introduction

The development of mobile devices and communication technologies has induced professionals and companies to look for new services for mobile phones. In recent years we have witnessed the discovery of numerous innovative services for mobile phones thanks to the prior creation of new technologies. The invention of these technologies is bound to lead to the further spread of new services in the future.

A huge achievement which indisputably reduced distance between people living in different parts of the world was the creation of the Internet. This invention enabled people to communicate without barriers, and soon on the basis of this technology new services have been created, just to mention such initiatives as Orkut [2], MySpace [3] and Facebook [4]. All of the mentioned initiatives share a common characteristic that they enable people to create a social network: the users can stay in touch with friends from the whole world, share pictures, talk, chat, send messages and look for new acquaintances [20]. Since social networking websites have been launched on Internet they have obtained a great success. Thanks to this success, the wide spread of mobile phones and the current development of numerous information and communication technologies allowed to create similar services also for mobile terminals [12].

The real advantage of mobile social networks compared to social networking websites is that mobile terminals elevate the freedom of movement while using the applications [19]. Moreover, using the wireless technologies in mobiles allows data sharing in peer-to-peer (P2P) networks with communication links created in ad hoc manner [17] [18]. Thanks to these technologies, applications enable spontaneous collaborative networks (in the following referred to as local social networks). However, local social networks are still a young concept and it is necessary to define whether they are valuable and appreciated by mobile users. The presentation of local social networks is still an unexplored challenge as well.

Additionally, social network sites offer numerous services. In comparison, mobile social networks can offer even more due to the integrated technologies (GPS, Camera, Wireless technologies, etc) of mobile terminals. However, the services of mobile social networks are crucially limited by specific mobile phone weaknesses/limitations (e.g. small screen, keyboard) which is less comfortable for the user in comparison to PCs or laptops. Thus, it is important to analyze whether despite the limitations of mobile phones it is possible to provide a similar package of services as the one offered by on-line social networks. This set of services has to be available in a single application and be completed by other services based on the integrated technologies of the mobile phones. Surely, these targets should be achieved without compromising the usability of the application and overall satisfaction of the user.
So, this paper is going to contribute to answering these questions:

1) Are local social networks valuable from the user's point of view?
2) Is it possible to provide an advanced set of social networking services on mobiles while preserving usability and satisfaction of the user?

In order to answer these questions the following methodology is applied. First, the state of the art is reviewed with the focus on mobile social networks. Secondly, a social mobile network application called Spiderweb is developed and used as a test case. The application offers

a set of services inspired by the ones of social networking sites. Other services are also provided utilizing advantages of integrated technology of the mobile phones. Spiderweb also uses a wireless technology to create local social networks. An original way to present local social networks is provided in order to contribute to user satisfaction. Finally, the application is tested by first users who are familiar with social networks and they are advanced mobile phone users. The tests concentrate on the usability and value of Spiderweb as perceived by the users and the results of the tests are applied in order to draw conclusions regarding mobile social networking services in general.

The rest of the paper is structured as follows: Section II provides an overview of some related work and explain the main concepts behind the mobile social network. In section III the Spiderweb application is presented. Section IV depicts conducted tests of the application as well as the obtained results. The next section discusses recommendation for further development of the application and further research. The last section draws the final conclusions.

II. Related Work

Nowadays the idea of social networking already extends to mobile terminals. Popular social networking websites as Facebook and MySpace are already providing the possibility to use their products on mobile phones. Basically, the service package is the same as the one offered in their websites. Additionally, users have the opportunity to combine the social networking with integrated technologies of the mobile phone while on the move. Other applications which exploit other resources of mobile phones (e.g. GPS and Bluetooth) have also been introduced in the market. For example, applications as Loopt [5], Dodgeball [6] and Mobiluck [7] focus on Localization Based Services (LBS) with social networks to help users to connect to other people and discover places around them [12]. Using these applications, users are able to connect with friends and be alerted when they are close. Additionally, they can share their current location, photos, etc. Users can explore points of interests and events recommended by friends. Other mobile social networking applications like Aka-Aki [1] and Nokia sensor [11] have the target to promote spontaneous communication between users. Using the Bluetooth technology, they are able to discover other users within a short range and exchange contents like profiles, messages, etc. A very interesting service is provided by Twitter mobile application. Twitter [8] can be described as blogging service with instant updates of new blog entries to followers. Followers are the friends who follow the user. This means that each message that the user uploads is displayed in his blog and delivered to the people who are followers. Two very original, however not well-known, mobile social networks are Zyb [9] and Groovr [10]. The first one replaces the phone book contents with an on-line advanced back up and synchronization system. Using Zyb, users of the application are able to back up their personal information as phone number, calendar and other contents. Friends of the user get updated once they synchronize their Zyb account. Thanks to this service, users can also find out who has them in their phones as a contact and even discover friends of friends. Through Groovr, users share information regarding events in chosen cities. They can post pictures, messages, or videos which are seen by everyone. The information provided by the users enables a real-time city exploration. Moreover Groovr allows the users to keep in touch with their friends by instant chat. The user can choose whether the information that he is looking for is retrieved from the Groovr pages of everyone or from friends.

III. The Application

To implement Spideweb different platform choices were taken into consideration and they are presented in [13]. Particularly, Symbian OS and Java 2 Micro Edition (J2ME) are the platforms which are chosen for the implementation of Spiderweb. Primarily, Symbian OS is leading the mobile market since several years, which as well supports J2ME programming language. The main advantage of J2ME is the portability thus it is determined that Spiderweb is compatible with other mobile operating systems supporting J2ME [13].

Spiderweb partly relies on the Internet connectivity thus offers several services already well-known from other social networking sites as Facebook and MySpace. In fact, users are able to create their profile and invite other users in their social networks. Users are also able to search people on the basis of certain filter criteria, exchange messages, let other users know their current position and keep in touch with their friends. Additionally, Spiderweb uses Bluetooth connectivity to allow devices to establish direct connections between them using the short range communication.

There is a notable difference between services based on mobile social networks already existing on the web and Spiderweb. In the first case, usually, the amount of data is vast and therefore it may be difficult to find needed information. In case of Spiderweb this amount of data is restricted to the range of the Bluetooth device. Significantly, the Bluetooth range is short enough to ensure that users are in the proximity of each other. At the same time it is long enough for users to scan without being noticed [18]. In Spiderweb, users within the Bluetooth range are part of a virtual world. The virtual world idea was inspired by a famous project called Second Life [21] which is an on-line 3D virtual life. In Second Life users have the freedom of virtual movements. They can meet each other, explore destinations inspired by real cities, attend events, etc. Using Spiderweb, the virtual world and the interaction between the users change depending on the location of the user. Spiderweb creates a virtual representation of the people within the Bluetooth range of the user.

The following section describes the architecture of the application. Subsequently, the on-line and off-line services of Spiderweb are presented.

A. Architecture

The architecture of the software application is based on the classical Client/Server model as shown in Figure 1.

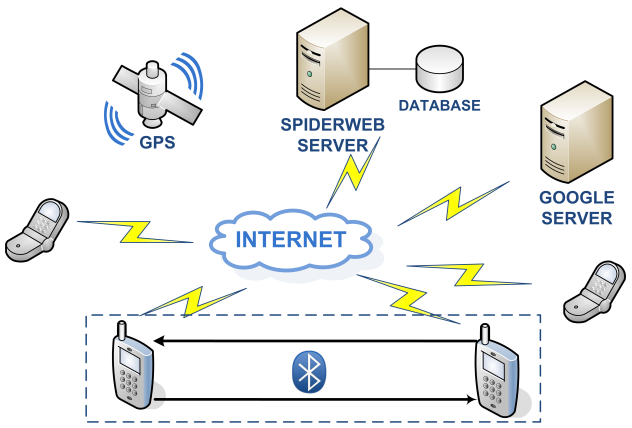

Fig. 1. Spiderweb architecture

Our server contains a database implemented on MySQL which includes information regarding all the users of the application. The communication between the server and the database is based on the Java DataBase Connectivity (JDBC). GPS satellites give the opportunity for the users to upload their current position to the database and retrieve the position of their friends using the Google map service provided by the Google server. The other elements of the Figure 1 represent an assortment of clients.

1) Internet connectivity: The cooperation between the client and the Spiderweb server is shown in Figure 2. The client starts the communication with the server (through an IP bearer technology) and sends a request (1). If the server accepts the connection with the client, it processes the request by translating it in a way that is understandable for the database (2) and then it sends the query formulated to the database (3). The database executes the query (4) and gives back its response to the server (5). The server processes the response by translating it in a way that is understandable for the client (6). Finally, the server is ready to send the response back to the client (7). Then the client presents the response received from the server in a way which is understandable to users of the application (8).

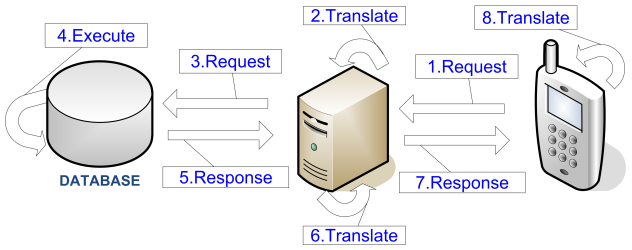

Fig. 2. Internet communication

2) GPS: To upload the current position of the user into the database the application performs two steps:

- Gets the latitude and longitude from the GPS satellite
- Uploads the current coordinates of the user to the database using the Internet connectivity described in Section III-A1

To retrieve the GPS position of a user, the application behaves as shown in Figure 3. The client starts the communication with the server (1), which processes the request by sending it to the database as it was described in Section III-A1 (2). Then the server sends back its response to the client (3) which forwards this response to the Google server (4). The Google server processes the request (5) and sends back the response to the client (6). This response is translated by the client and visualized as an image which indicates the last updated GPS position of the required user (7). The use of the Google server is subject to a query limit of 1000 unique (different) image requests per viewer per day [14]. For this reason, the connection between the Spiderweb client and the Google server is preferred to the one between the Spiderweb server and the Google server.

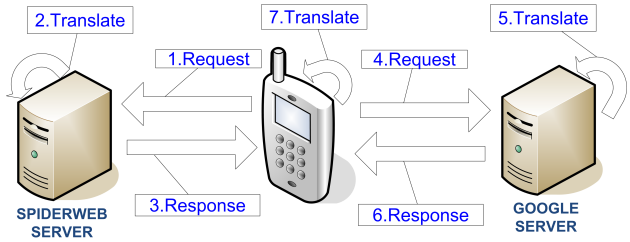

Fig. 3. Retrieving the GPS position of a user

3) Bluetooth connectivity: Figure 4 constitutes an enlargement of the rectangle located in the bottom of the Figure 1. Each node of the P2P network can simultaneously play two different roles: server and client. In fact, as it was shown in Figure 4, in each mobile device a server and a client are running in the same time. The task of the server is to publish a service and accept concurrently connections, whereas the task of the client is to search and connect to services [15]. First a client conducts a device discovery, which consists in searching of all Bluetooth devices present in the range, including the ones which are not running the Spiderweb application. Therefore, certain filters have been implemented to narrow down the

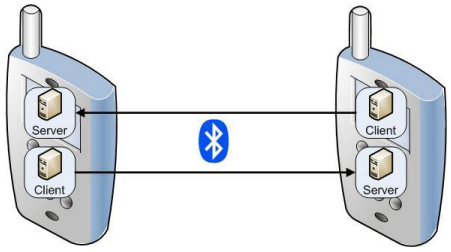

Fig. 4. Bluetooth communication

search to devices satisfying particular conditions. In particular, due to the fact that Spiderweb is running only on mobile phones, the search does not embrace other sorts of Bluetooth devices. Including other kind of devices in the search would be tantamount to a waste of time and energy, since the found devices would need to be analyzed afterwards. However, it is unsure if the found Bluetooth devices are equipped with the Spiderweb application. Therefore a service discovery is needed. The service discovery investigates each mobile phone filtered from the device discovery. If some device satisfies this requirement as well, the two devices (the one which is conducting an inquiry and the one which is discovered) are able to communicate and exchange data.

B. Spiderweb services

Spiderweb offers numerous services to the users. When the user registers he fills a profile which is sent to the server using the Internet connectivity described in Section III-A1. A sub-set of this profile called Business Card (in the following referred to as BC) is stored in the local memory of the mobile phone. An example of a BC is shown in Figure 5-b.

1) Off-line services: In off-line mode the user is able to log in to the application and create picture and text messages. If the user is not connected through any Internet connection, he can store those messages into the local memory of the device and later send them all together once an Internet connection is established.

Additionally, during the off-line mode the user is able to use Bluetooth connectivity and be a part of Peer-to-Peer communication controlled by a network of mobile devices (refer to Section III-A3). This network serves as an environment for exchanging various content. Users of the application are able to exchange their BCs, messages and contact invitations. A nice user interface resembling a game constitutes a strong part of this service. Its aim is to create an impression of being a part of a virtual world for users. The environment of the virtual world is represented by a tea shop as illustrated in Figure 5-c. As shown, users can find different kinds of virtual people, each of them representing a person/device within the Bluetooth range of the user. The virtual people have different pictures, depending on the relation to the user (unknown people, friends, etc). In this way the user can easily understand who is inside his virtual world. Moreover, the user also has the opportunity to place some friends on a watch list and be alerted by the application once these friends appear in the Bluetooth range of the user.

2) Online services: All the services, which are going to be presented in this section, make use of the Internet connectivity (refer to Section III-A1). Figure 5-a shows the screenshot after the user has logged in to the application. This is an example of the notification screen of Spiderweb.

Notifications regard whether a friend updated their profile, current status, GPS position, sent text and picture messages to the user and new friendships. From the notification screen shown in Figure 5-a, using the icons in the bottom, the user can perform actions which are described in the following.

The user is able to **find people** using filtering criteria: Contacts (name, surname, etc), Relationship (single, looking for partner, friends, business relations, etc), Education (for instance people from the same high school or university), Work (to find people with whom the user has been working with) and Personal (who like the same books, movies, activities, etc). After choosing the filtering criteria, the application gets a list of users who pass the selected filters. Now, if the user chooses one element of this list, they can see either the full profile of the found person or only their BC, depending on whether they are friends or not. Figure 6 shows the actions that the user can perform depending on whether the selected element is a friend or not. Like similar social networks, Spiderweb also gives the opportunity to have a **list of friends**. Being a friend gives the advantages to receive notifications from this person, seeing his full profile and perform the actions shown in Figure 6.

The user is also able to **update** his **GPS position**. The application starts to look for the GPS signals to get the latitude and longitude of the user. In case Spiderweb is not able to find it (for instance, if the user is inside a building), the user has the opportunity to type the street address of his current position. This address is converted into latitude and longitude coordinates by the Google server. In both cases, the data are sent to the server and uploaded to the database.

When the user **retrieves** the **GPS position** of a friend, the application gets the latitude and longitude from the Spiderweb server and sends them to the Google server, which returns a Google map, indicating the user's location along with neighbour places, streets and POIs (refer to Section III-A2). For convenience, zooming is also supported.

The last service described in this section is **Messaging**.

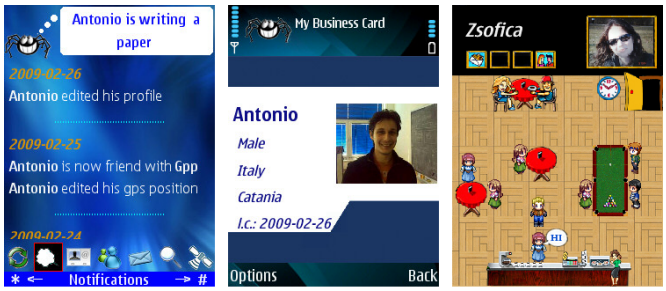

Fig. 5. Three screenshots of Spiderweb

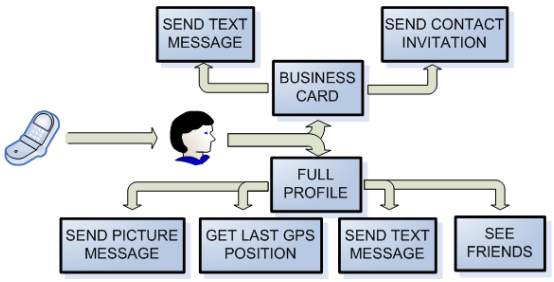

Fig. 6. Actions performed by the user

Users of this application are able to upload and download pictures and text messages to/from the server.

IV. Evaluation

In this section the results of usability tests and general evaluation of the application are presented. The usability tests refer to the level of difficulty of using the mobile social networking services. Further, the general evaluation refers to the overall assessment of the Spiderweb. These tests were conducted by students at Aalborg University. In total 18 participants were recruited. The average of the students was 22.5 years old. All the participants were male and they had experience with at least one of the most well-known social networking sites as Facebook, MySpace, etc. The students used the Spiderweb application for several days and fill a questionnaire at the end of the tests.

A. Usability tests

To perform the usability tests, students were asked not to use the Spiderweb user guide, since typically, when customers get a new application on their mobile phone, they do not read the instructions but run it immediately instead. In case the students testing the application were unable to perform a particular action, they were allowed to consult the Spiderweb user guide. Figure 7 shows the results of the usability tests of the main services offered by Spiderweb.

Students were asked to evaluate the usability of the Spiderweb services described in Section III-B. The evaluation consisted of tasks ranging in difficulty between "Very Easy" and "Very Hard". More than 70% of the services were evaluated as "Very Easy" task. This implies that Spiderweb is easy to use and users are able to understand the functioning of the application quickly. The only action, which requires design improvements to reduce its complexity, is the virtual world service.

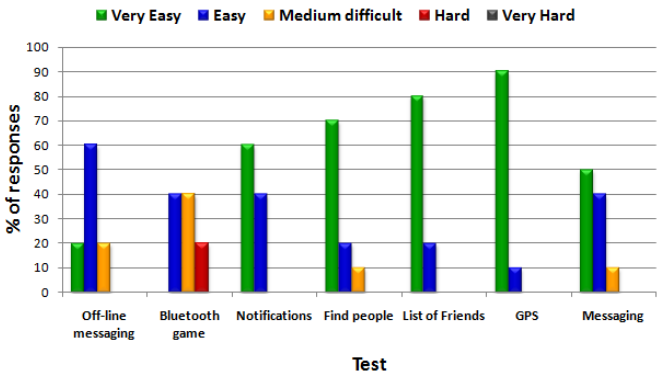

Fig. 7. Results of the usability tests

B. General evaluation

At the end of the questionnaire the students were asked the following general questions:

- Spiderweb idea: How do you evaluate the idea of the application?

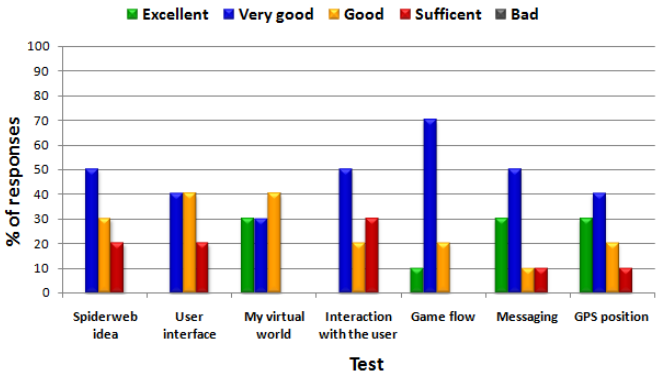

Fig. 8. Results of the general evaluation tests

- User interface: How do you evaluate the user interface of Spiderweb?
- My virtual world: How do you evaluate the idea of the virtual world?
- Interaction with the user: How good is the interaction with the user?
- Game flow: How good is the game flow of the application?
- Messaging: How do you evaluate the service of storing text and picture messages in the local memory of the device and send all together once an Internet connection is established?
- GPS position: How do you evaluate the idea of uploading your GPS position and let your friends know where you are?

The results are presented in Figure 8. On the basis of these results it can be concluded that the Spiderweb application was evaluated as an interesting application. In fact, 75% of the students thought that it was an innovative idea in the sense that it was not widespread on mobile devices yet. 90% of the students did not know any similar application running on mobile phones and 63% of them would use the application.

While performing these tests all the students pointed out the speed of the Bluetooth discovery as an important weakness of the application. In order to analyze how fast the Bluetooth discovery is, numerous tests were performed. We implemented a timer in the application and measured how fast is the Spiderweb Bluetooth discovery. Before showing the results, it is important to notice that Spiderweb Bluetooth discovery is composed of three steps:

1) Device discovery: searching for Bluetooth devices (more details in section III-A3);
2) Service Discovery: investigating whether each of the Bluetooth devices found is a Spiderweb user (more details in section III-A3);
3) Exchange of the Business Cards: once a Spiderweb user is found, the discoverer and the discovered users exchange their BCs.

Figure 9 shows the results of the Spiderweb Bluetooth discovery tests. Particularly, axis Y presents the milliseconds passed till the Spiderweb Bluetooth discovery ends and axis X shows the number of found devices.

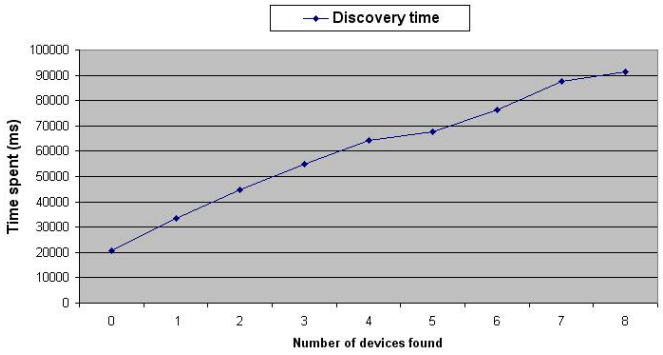

Fig. 9. Bluetooth discovery time

V. Future Work

In order to make Spiderweb a more interesting and commercially ready product, some improvements can be suggested. One of them would be the opportunity for users to record video, store it in the local memory of the device in case no Internet connectivity is available and send it once Internet connection is established. Indoor positioning by means of Wi-Fi access points is currently being investigated in order to give the possibility for friends to know where the user is indoors. Another important aspect that must be taken into consideration is security. In the current version of Spiderweb specific security measures were not addressed. However, if the application would be expanded the security of the application ought to be increased as well. Results of conducted tests suggest that the time-consumption of the Bluetooth discovery is a major weakness of Spiderweb. A possible way of overcoming this weakness could be to add Wi-Fi as P2P communication. This solution is recommended to be investigated.

Furthermore, a study on the user profile must be conducted. Particularly, having the possibility of sharing more information regarding the users in the virtual world will make Spiderweb much more interesting application. A study which investigates what the users require in order to enable sharing of personal data and in which conditions sharing of personal data is acceptable for the users is recommended. Finally, a notification system, which alerts about other ”interesting users” within the Bluetooth range, is also suggested. The ”interesting users” would be highlighted according to the user preferences.

VI. Conclusions

A mobile application which enables the establishment of social networks is successfully implemented. This prototype offers a set of social networking services supplemented by others based on the integrated technologies of the mobile phones (e.g. GPS, camera). Additionally Spiderweb enables the establishment of spontaneous collaborative networks over Bluetooth wireless technology. The application creates a virtual representation of the people who participate in the local social networks. Spiderweb already represents an advanced level of implementation presenting only some minor issues to be solved and further tested. Therefore, Spiderweb is not a commercial product yet; it still has some drawbacks and particularly limitations, caused by low speed of the Bluetooth discovery.

Spiderweb was tested to evaluate its usability and the user satisfaction in order to analyze the users' perception of mobile social networking services. Test results show that more than 70% of the Spiderweb services were evaluated as a ”Very Easy” task to perform. Additionally, users were satisfied with the Spiderweb services since the 63% of the users would use the application if possible. Thus, these test results prove that it is possible to provide the corresponding functionality of social networks, and even more services on mobiles while still preserving usability and satisfaction of the user. The idea of building local social networks was evaluated as an innovative idea as it is shown in the test results. Among other services, users found the virtual world to be very valuable and interesting aspect. They appreciated the opportunity of having a virtual representation of the user vicinity. Specifically, they liked the concept of knowing the people who were in the proximity of the user. These people were not complete strangers for the user anymore. Thus, the virtual world provides a way to see connections between the users, which were previously hidden, within the Bluetooth range. This opportunity is delivered to the user by making the relevant information about the environment to be easily accessible and immediately available to the user.

Finally, we can conclude that such design limitations of mobile terminals as small keyboards and screen cannot be a valid reason why social networks are not broadly spread on mobiles. It is thus advised to investigate other reasons, which could influence low spread of mobile social networks. It could be expected to be lack of flat rate popularity or insufficient number of advanced mobile users.

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