Understanding Mobile Relationships

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Abstract

Recent advances in mobile technology and media convergence present new issues to both researchers and designers, which are strictly connected with the adoption of mobile services; the main challenges seem to be linked not only to technical aspects, but especially to human factors. In order to understand human relationships in a mobile environment, here defined as mobile relationships, we make a parallel between social software and mobile social software. Extending Shirky's definition of social software, we defined mobile social software as "kind of software that supports interaction among networked mobile users". Finally, we used Martti's framework to analyse the social impact of mobile interactions, presenting and comparing some existing mobile social applications. Identity, trust and user control of information flow seem to be among the most important parameters affecting the acceptance and utilisation of mobile social applications.

1. INTRODUCTION

As Barry Wellman (2001) wrote a few years ago in a famous article, "*computer networks are inherently social networks, linking people, organizations, and knowledge*". According to Wellman, "*work, community and domestic life have largely moved from hierarchically arranged, densely knit, bounded groups to social networks*". The large amount of so-called social software, which developed from simple Internet chats, like IRC, and still very popular, to very sophisticate three-dimensional online environments, where it is even possible to build a virtual representation of the self, the avatar, and "*live a second life*" (Ondrejka 2003). The advances of mobile technology and media convergence today allow extending the paradigm of social software to mobile environments, adding even more features to the previous generation of social software. Today, it is possible to switch easily from a task in the physical world to another in the cyberspace, with a relatively small cognitive effort. Let's imagine one going out from work, walking in the street and catching a bus to go home. While on the move, it is possible to have a chat with a friend through a mobile messenger client. Although the traditional utilisation of mobile social software is "*communication*", the possibilities of new interactions are unlimited, ranging from entertainment and work to time and contact management. Some innovative applications start to appear in the market; making use of personal information, such as location, availability or data, to deliver information to a variety of people with whom we might be more or less acquainted, such applications often present privacy concerns. Today, the feeling of being not in control of what information goes to who represents one of the main obstacles to the adoption of innovative mobile social services. Hence, it is of crucial importance not only to develop the technology needed to support everyday social practices, but especially to understand the meaning of such relationships in a mobile environment.
This paper wants to be a starting point for a discussion around mobile social relationships, "*understanding and using them according to our needs*" and is organized as follows: section two describes the theoretical framework of the study, presenting a general framework to study mobile relationships. In section three and four the history of Social Software and of Mobile Social Software are presented, with well-known examples of current available applications and services. A comparison of social software and mobile social software is treated in section five, with a short discussion of their key features and properties. Conclusions of the whole study are presented in section six.

2. THEORETICAL BACKGROUND

2.1. A General Framework

A suitable framework to investigate the social impact of interactions in a mobile environment is presented by Marti (2002), who considers relevant in the context of mobile communication three classes of relationships:
- Class A: social impact on relationship between person and machine/medium
- Class B: social impact on relationship between person and co-located people

- Class C: social impact on relationship between person and two (or more) mediated people

Marti's distinction is based on the earlier work done by Dryer et al. (1999), with the goal of understanding the influence of user interface design on the social impact of mobile communication, defined as "*influence on relationships between social actors*". For our purposes, the classification is useful because it considers the mobile device as a social actor, and makes a separation between mobile interactions of co-located and not co-located people.

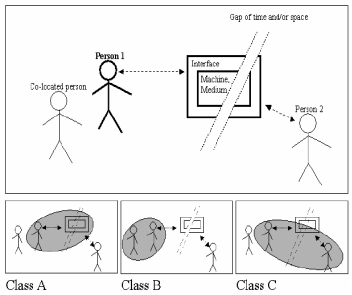

Figure 1: Classes of Relationships (Marti, 2002)

As we will see in the next sections, most mobile social software focus its activity only on one of the three classes and very little attention has been paid to the relationship between individual and mobile device. The mobile phone, being almost always with the mobile user, has the possibility to keep track of communications, actions, locations, habits…of the mobile user, transforming "*implicit knowledge*" to "*explicit*" and presenting it back to the mobile user, with specific actions to be performed.

3. SOCIAL SOFTWARE

3.1. History of Social Software

The term "Social Software", quite in fashion today, is a very recent invention, used for the first time in public in late 2002 by Clay Shirky, who organized a "Social Software Summit" in November of that year. According to Shirky, social software is "a *kind of software that supports group interaction*" (Shirky 2002). Today, this term has a wider impact, including people rendezvous, connections and collaborations through computer networks or, more generally, through networks. Although the term social software is young, its origin goes back to the '40s, with Vannevar Bush's ideas about '*memex*', and went through a number of different phases: 'Augmentation' ('60s), 'Groupware' ('70s-'80s) and 'CSCW' ('80s-'90s). In the '40s, near the end of World War II, Vannevar Bush wrote a seminar article on the future of computing in "*As We May Think*". In it, he conceived of a device he called the '*memex*', very similar to today's personal computer: "*A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory."* The article also discussed Memex's benefits to groups, even mentioning the hypertext, seen as a "*new form of encyclopaedia, ready-made with a mesh of associative trails running through them, ready to be dropped into the memex and there amplified*" (Bush 1996).

In the '60s, thanks to the Advanced Research Projects Agency (ARPA), the idea of using computers to communicate and collaborate came again, leading to ARPANET, a network to be used to interconnect universities and research laboratories. ARPANET is considered as the 'father' of today's Internet. At the end of the '60s, Licklider (1968) wrote an article "*The Computer as a Communication Device*", where he also described methods of collaboration and how people function in groups. In that period the computer was perceived as a tool to augment the human senses and intellect. In "*Augmenting Human Intellect: A Conceptual Framework*", written in 1962 by Douglas Engelbart, considered one of the Internet pioneers, he presents the basic idea of augmentation: "*by augmenting human intellect we mean increasing the capability of a man to approach a complex problem situation, to gain comprehension to suit his particular needs, and to derive solutions to problems*" (Engelbart 1962). Engelbart was also among the first to say that in order to design tools which would help to achieve his vision, we must "*integrate psychology and organizational development, with all of these advances in computing technology*". However' Engelbart's work was sold to a commercial company, which used it for "Office Automation Division" tools. The term 'automation' replaced 'augmentation', and the original ideas of integrating psychology and organization development were lost.

One of the most important projects funded by the "*office automation*" line was called Electronic Information Exchange System (EIES), considered the first major implementation of collaborative software. Although EIES was too cumbersome, it featured threaded-replies, anonymous messages, polling…and it introduced terms like "*decision*

support system", "*computer-mediated communication*" and "*collective intelligence*". After experiencing EIES, in 1978 Peter and Trudy Johnson-Lenz coined the term "*groupware*", defining it as "*intentional group processes plus software to support them*". Intentional implies conscious design, and the definition supports the idea that group processes come before the software. In the '80s the academic community was not happy with either the term 'office automation' or 'groupware' for research into how groups use computers to collaborate; after the failure of an ACM conference on Office Automation, MIT's Irene Grief and DEC's Paul Cashman coined the term CSCW for a workshop held in 1984, which was followed by the first CSCW conference in 1986. There was a discussion around the 'second C' of CSCW: HCI people preferred the small team focused '*cooperative*', whereas the IS people chose the broader '*collaborative*'. Most definition compare CSCW to Groupware, but for our purposes the best definition comes from the Digital Media Laboratory: "*CSCW is a multidisciplinary research field including computer science, economics, sociology, and psychology. CSCW research focuses on developing new theories and technologies for coordination of groups of people who work together*". In 1988, the term Groupware hit the mainstream when Robert Johansen wrote the best-selling group "Groupware: Computer Support for Business Teams". This success was also the beginning of the downfall of the term; today's definition of Groupware is "*software that integrates work on a single project by several concurrent users at separated workstations*" (Allen 1995). Today almost any software which supports multiple users can somewhat legitimately say that they are "groupware".

Already in the '90s various specialised groups started to use the term '*social software*' in their discussions in usenet newsgroups; the term was initially associated with the nanotechnology community and those influenced by them; the term was used by Eric Drexler, founder of the Foresight Institute, who also coined the term "*nanotechnology*". He used the term "*social software*" in his writing "*Hypertext Publishing and the Evolution of Knowledge*", originally published in 1987, but updated online in 1997. According to Drexler (1987), he used the term "*social software*" because "*concerned with communication and collaboration on all scales, including the whole of society. […] Media and he world wide web are forms of social software*". As previously stated, the term "*social software*" as used today is not the one used in the '90s by the nanotechnology community, but the one introduced by Clay Shirky. He said that the term had not to contain words related to the ancestors, including groupware and CSCW, because otherwise it would have appeared to the public as a sub-set of groupware or CSCW. Social software inherits and enhances its predecessors, supporting both "*online*" and "*offline*" interaction, individuals, groups and communities of any size.

Shirky also distinguishes "*social software*" and "*social computing*", which are often considered as synonyms: according to him, "*social computing phrase is a shame for two reasons. First, there's no need to apologise for studying social effects by pretending that they are a form of computing; second, the phrase social computing could describe a really interesting domain, where groups are used to find approximately optimal solutions to hard combinatorial problems*" (Shirky 2002). For some time there has been a discussion on the definition of "*social software*", especially about its scope; one of the most interesting ones comes from Tom Coates, "*augmentation of human's socialising and networking abilities by software, complete with ways of compensating for the overloads this might engender*". According to Adina Levin, of SocialText, "*many of the attributes of social software – hyperlinks for naming and reference, weblog conversation discovery, standards-based aggregation – build on older forms. But the difference in scale, standardization, simplicity, and social incentives provided by web access turn a difference in degree to a difference in kind.* […] *People are compelled to write blogs and journals to show off and to share, to contribute to wikipedia and open source software projects for the joy of building things with other people. There are some lessons about social patterns and social affordances that this generation of social software communities and tools get right, are worth understanding and building on*".

4. MOBILE SOCIAL SOFTWARE

4.1. Definition and Scope

If the term social software is young, we can consider "*mobile social software*" as a baby; on September, 18th 2005 the number of mobile subscriptions in the world exceeded 2 billions, and by the end of 2010 they will reach 3 billions (GSM World 2005). All the GSM subscribers can use the simplest kind of mobile social software, the text message. However, only a minority can take advantage of GPRS or UTMS connectivity used by applications running on Smartphones. In a few words, truly mobile social software cannot reach the masses yet, since the technological platform is not widespread yet. Nevertheless, a Microsoft researcher, Pedram Keyani, has started in 2004 to collect information about existing mobile social applications and typical individual and group utilisations. Finally, he made his results public, with the aim of finding, through the collaboration of people with the same goal, a definition for "mobile social software". According to Keyani (2004), mobile social software can be described according to three distinct areas:

Anytime/Anyplace Coordination and Convergence: software which provides loose or tightly defined groups to

chat and plan activities. Existing systems are mainly communities of mobile users supported by a web-site; they might be focusing at local level, country level or global level. A similar way of communication, swarm (Ross 2004) is meant for smaller intimate groups to keep in touch and coordinate on-the-fly. A popular application, Dodgeball, is less for coordination, but more about last minute convergence through location broadcasting.
Proximity-based profile sharing: software that, according to the promises of launch campaigns, can make true the dream of any single person, being able to walk into a bar/club and find out who are the single men and women. Better yet, who are the single men and women who like the same activities that you do or who know some of your friends. While the Lovegety is the original high tech love beacon, systems like Mobule, and Proxidating have taken it to the next level by allowing you to setup a profile and filter people based on different features.
Mobile Social Games: software that allows a much richer game experience in real environments often augmented with virtual elements, present in the mobile devices. Besides interacting with the environment, these games get you off the couch and let interact with other people. Noderunner is an example of '*digital street game*', letting teams compete in discovering Wlan hotspots; Human Pacman is based on the traditional videogame concept, but it takes place in a real environment.
The author has not yet classified things like mobile photo blogging, which fall more in the realm of long term community building, and comments to his effort show that still important aspects have to be investigated further and possibly included in the definition of mobile social software. Such aspects are "*enhanced interaction with environment*" (not only for gaming), "*collaborative definitions and recommendations (of places, objects, people, services)*", seen also as "*public authoring (or authoring in public)*" (Lane 2004) and "*personal security and identification*", connected also to the "*trust*" issue. In our opinion, the definition of "*mobile social software*" could simply extend Shirky's definition of social software; in this perspective mobile social software would be "a *kind of software that supports interaction among networked mobile users*". The definition considers the crucial property of mobile users, mobility, and the fact that there is an invisible "*social link*" which keeps them interconnected and thus allows a certain kind of interaction, dependent on the kind of "*social link*", which is the projection of people's relationship in the mobile space. Hence, it is of crucial importance to understand the meaning of "*social link*" and associate it with "*interaction-styles*", which should include a certain control over the resources and information; not only with whom we want to interact, collaborate or share, but also which information will be shared. These key-concepts will be investigated in more detail in the next sections. As we can see, to be able to develop useful applications which would allow exploiting the knowledge and power of social connections, before working on the technology, we have how to deal with human relationships and their dynamics. The new insight and results of the research in this field could extend the existing methods of the field of Social Network Analysis (SNA), which sociologists, anthropologists and psychologists have investigated in the last sixty-seventy years.

4.2. Examples of Mobile Social Software

In this section, we will introduce five examples of mobile social software, both academic (Sociometer, Reality Mining, Context Software) and commercial (Nokia Sensor, Live Addressbook), focusing on the following aspects:
- *contact and group management:* structure, views and features of address-book or buddy-list; which actions are enabled and with which criteria; possibility of creating groups and group-interaction modes.
- *privacy, identity and trust:* potential privacy threats; methods of authentication of the user, avatars, relations between real-life identity and cyber-identity; criteria used to map real-life relationships and mobile relationships.
- *control of information flow:* trade-offs in updating information: application vs user; strategies for enabling controlled access to resources and information.

We have selected such applications because they present interesting aspects, which could be perhaps merged together in future mobile social applications. On purpose, we did not consider the "*mobile version*" of existing "*social software*", like Mobile Instant Messaging, but applications which, in some ways, make use of the peculiar properties of the mobile phone.

- Sociometer

The Sociometer is a system developed at the MIT Media Lab, based on the studies of Choudhury and Pentland on the influence model (Basu et al. 2001). Using that model, the researchers have developed methods for learning the structure and dynamics of human face-to-face communication networks. The idea behind the Sociometer is that wearable sensor data combined with pattern recognition techniques can play an important role in sensing and modelling physical interactions (Choudhury et al. 2004). The system, introduced before smartphones appeared in the market, can be considered a mobile social application, since mobility was taken into account: experiment participants agreed to wear the Sociometer, letting it record data about their daily face-to-face interactions. The sociometer has an IR transceiver, a microphone, two accelerometers, on-board storage, and power supply. The wearable stores the data

locally on a 256MB compact flash card and is powered by four AAA batteries. A set of four AAA batteries is enough to power the device for 24 hours. Everything is packaged into a shoulder mount so that it can be worn all day without any discomfort. The sociometer stores the following information for each individual:
(i) Information about people nearby (sampling rate 17Hz – sensor IR)
(ii) Speech information (8KHz - microphone)
(iii) Motion information (50Hz - accelerometer)
The goal of the Sociometer was not to allow contact and group management, or control over information flow, but simply to let researchers gain a deeper understanding of the dynamics of human relationships, in particular of face-to-face interactions, considered the most efficient and richest of the communication channels. Before the Sociometer, there had been no previous work on modeling face-to-face interactions within a community. That absence was probably due to the difficulty in obtaining reliable measurements from real-world interactions. Thus, one of the important achievements of the Sociometer is that it opened a new path of research for future mobile applications.

- Reality Mining

The Reality Mining is the development of the Sociometer in a mobile environment. The system consists of a client and a server, and is a combination of commercial hardware running specialized software. The PDAs containing standard personal information management applications were augmented with the ability to continuously stream and store audio and establish the proximity of others. The largest benefits of the system are realized as it scales. Detailed information regarding the dynamics of the face-to-face communication within the workplace can be quantified and correlated with the roles individuals play in an organization's social infrastructure. The data captured by sensors and microphones was stored locally and then sent to a server to a server, where conversation detection, analysis, and inference software were written to process multiple large audio files in parallel.
Several applications were written for specific purposes, the most interesting (for our purposes) being *Group Mapper* (Eagle 2005). The application could generate and publicly display dynamic maps of social infrastructure, reflecting the roles and dyadic relationships that individuals have within a work group. The hope of the researchers was that such analysis could help with such tasks as determining who to ask for help, identifying isolated cliques, and a gaining a deeper insight into the underlying dynamics of the organization. Architects have expressed interest in using this system to monitor how small changes to the interiors of buildings have an effect on the office communications.
The original Reality Mining system later evolved in a large project, addressing the following questions:
(i) How do social networks evolve over time?
(ii) How entropic (predictable) are most people's lives?
(iii) How does information flow?
(iv) Can the topology of a social network be inferred from only proximity data?
(v) How can we change a group's interactions to promote better functioning?
The Reality Mining project makes use of the Context Software, which we briefly introduce in the next section.

- Context Software

Context software is an application for Smartphones developed at the Computer Science Department of the University of Helsinki by Mika Raento. Context software consists of four interconnected main modules:
- *Sensors*: used to acquire context data from different sources, such as location (cell identifier and GPS) or phone usage.
- *Communications*: provide connections to services in the outside world via standard Internet protocols using GPRS, Bluetooth transfers, short messages (SMS) and multimedia messages (MMS). The communication channels can be used, e.g., to share presence information (Jabber) or to obtain sensor data (GPS over Bluetooth).
- *Customizable*: versions of built-in applications} are provided, in particular for the Contacts and Recent call list, to seamlessly replace the original ones.
- *System services*: provide facilities for automatic starting of background services, error logging and recovery as well as status display.
Context Software (Raento et al. 2005a) provides several applications, Context Contacts, Context Media and Context Logger, for the interaction of the user with the application. Context Contacts replaces the traditional mobile addressbook with an enhanced version, which associates to each contact contextual cues, as shown in Fig.2. The application does not allow an enhanced group management, although group coordination and opportunities for action have been investigated (Oulasvirta et al. 2005). The new version of the application allows also a control over the self-disclosure of own contextual cues, allowing the user to choose to whom show them, selecting from a list of pre-defined groups (friends, family, work). Context Software chooses a '*manual*' approach to the problem of matching contacts and groups. From this perspective, it provides full-control to the user, at the costs of heavy manual updates. The application Context Media enables not only the capture of media, but also the annotation and sharing of this

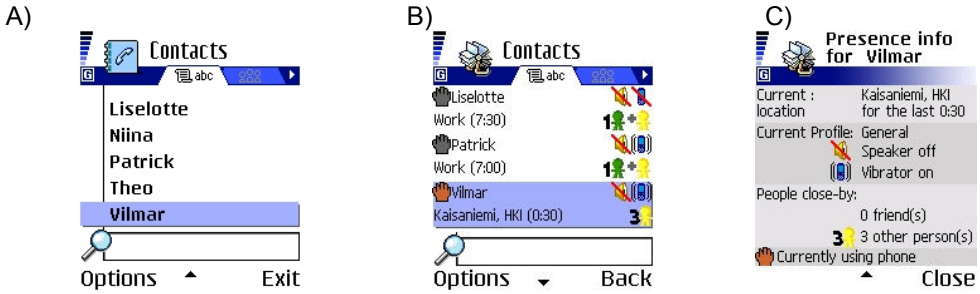

Figure 2. A) The standard, non-augmented contact book of Nokia 6600, B) ContextContacts, C) a detailed information screen for the highlighted contact in 1B. See Table 2 for an explanation of the icons.

media (photos, sound, video, text). Context Logger is an application for recording mobility data. The goal has been to provide a tool for researchers to acquire rich data in a manner that is unobtrusive to the user, requires minimum control and maintenance, and is robust and reliable. Of course, the data can be used by the users themselves to keep an automated diary, but the application does not provide a user-friendly way of visualising information (i.e.: views of social network), selecting and sorting it, in a way that could be accessible and understandable to everybody.
Context research group is also progressing towards a better understanding of "*privacy implications for social awareness applications*", and the design is inspired by social psychological theories (Raento et al. 2005b).

- Nokia Sensor / Digidress

Nokia sensor is a commercial product launched in May 2005, based on an earlier prototype called DigiDress (Persson et al. 2005). The application takes its origin from the observation that mobile phones have traditionally been used to connect *remote* people, but today's technology (Bluetooth, W-LAN and other short range radio frequencies) allows mobile phones also to be used to connect *proximate* or *co-located* people. From this perspective, mobile devices could exchange data with or without the users' immediate awareness. The research project wanted to investigate encounters between spatially proximate people and strategies to let information in digital realm support and augment existing social behaviour, practices and experiences taking place in real space. The Digidress application, designed for Smartphones, had the following features:
- *Creating identity expression:* the identity expression editor editor was at the core of DigiDress. The DigiDress is a sort of media-rich user profile, where fields can be edited by the user leaving space to their freedom of expression and creativity.
- *Lookaround*: the application allows scanning the environment for other DigiDress users and Bluetooth devices, presenting them in a list. The identification of users is not based on phone numbers, but on the unique Bluetooth device identifier (MAC address). If the identified device was running DigiDress application. From the list, user could choose to browse the full contents of the other user DigiDress. The viewer can also save the DigiDress locally, send Bluetooth messages, add public comments or view the comments this user had received from other users. The creators obseve that "*lookaround and viewing DigiDresses were conducted without prompting the DigiDress owner for authorization. […] Neither was owners made aware that another user was downloading the DigiDress pages. The only trace of someone's viewing the pages were provided in My Popularity feature, which listed the number of 'views' the DigiDress had received as well as the timestamp of those. This rather 'public' design of the system aimed to be in line with the design principles presented above, mimicking existing social practices in public spaces*" (Persson et al. 2005).
- *Bluetooth messages*: Bluetooth messages are simple and private text messages between two users. Recipients, who were notified with a sound signal, could reply to an incoming message but not store them.
- *Comments*: comments provided a more public form of communication. Received comments were automatically stored in a list, available not only to the page owner, but could be accessed by any visitor to a DigiDress .

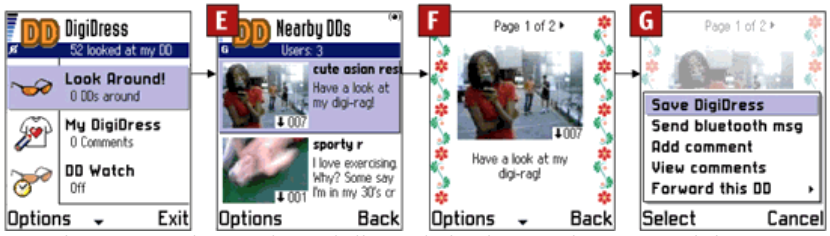

Figure 3. Lookaround, result list and viewing another user's DigiDress.

In this way comments worked as a proximity 'guestbook'. Page owner could delete any comments, and also add own comments.
- *DigiDress watch*: The DigiDress watch feature allowed users to set a time interval for automatic Lookarounds. If a DigiDress device was found nearby, a sound notification would be delivered.
Results of the user studies conducted show that "*viewing the identity expression of people nearby was one major motivation for continued use*", "*direct communication features such as Bluetooth messages were not commonly adopted*" and "*Privacy concerns and their alleviations, as well as use barriers, were identified*" (Persson et al. 2005). From our perspective, the DigiDress application takes into account the theme of digital identity, as public presentation of the self to the others. The identity expression procedure leaves space to the creativity, but it does not provide an authentication method, so it leaves to the user the task of evaluating how trustable is the presentation of an unacquainted user who is nearby. In addition, the designers' decision of keeping profiles public and fully browsable adds fun to the majority of users, but might also by used in a malicious way. The users do not have full control over the information flow: to avoid the own profile being browsed is to shut down the application. During the user study, a user suggested that "*viewing a DigiDress should always be preceded with a request to its owner*". In conclusion, this kind of application could be fun to use in certain situations (clubs, bar, parties…), but in other environments Digidress identity expressions should not be taken too seriously.

- Live Addressbook

The Live Addressbook, commercial application of AT&T, developed by Milewski and Smith in 2000, aims at augmenting telephone calls with presence, defined as "*location, availability and anything needed to negotiate the conversation*". Among others, identification of the caller, topic of the call, eagerness to talk, mood, friendliness, urgency of the content, estimated duration of the call were taken into account. The application was designed to answer to the problem of telephone caller's lack of information about the people they want to call, which caused unwanted interruptions and missed connections. The design issues that were investigated in the user trials were the following:
- *Informativeness vs privacy*: how much information to show?
- *Overhead vs control*: how to keep information up-to-date?
- *Publish/Subscribe vs Situated Negotiation*: how to convey the information?
Results of the studies show that "*personal location and availability information are both useful for telephone communication*", "*telephone buddy-lists can peacefully co-exist with standard personal phonebooks*". About the trade-off overhead vs control, studies confirmed that "*users will attempt to keep personal presence information current, especially if the overhead is low)*" and "mixing auto-detection and manual updating is a useful (and low-risk) overhead reduction strategy. In addition, personal availability information is much more difficult to keep current than location. Concerning the third design issue, it seems that "*publish/subscribe works well for location information*", and "*situated negotiation of availability may be superior to the publish/subscribe model*" (Milewski 2000). The Live Addressbook lacks addresses most of the design issues that we identified in the previous paragraphs, although it does not consider groups and not link controlled access strategies to the kind of relationship / trust a contact has with the caller.

5. SOCIAL SOFTWARE AND MOBILE SOCIAL SOFTWARE

From the examples of social software and mobile social software that we presented, we can observe a clear separation of supported classes of relationships: the former mainly supports computer-mediated relationships (Marti's Class C) and the latter offers possibilities for improved interaction the device (Martti's Class A) or with co-located people (Marti's Class B). However, the interaction between user and device has been mainly studied from the perspective of usability. As Biever (2004) wrote in his article, "*The phone knows you better than you do*"; this motto introduces a new perspective from which to study interaction between user and device. It is not only the user that has to learn and adapt to the mobile device and its features, but also the other way around. The device could gather data, extract and make use of implicit "*knowledge*" about the mobile user, which could be presented as explicit knowledge to the user, thus offering new forms of interaction with social groups and with the surrounding environment.
Logically, we could split this process in two phases: in the first one is machine-controlled, with the application gathering data, analysing it, clustering and preparing it for the second phase, in which the user has the control to give a meaning to it, adjusting to his preferences, choosing the preferred view or visualisation, excluding what is not needed…in a few words, the machine should measure the evolution and strength of social relationships, the user should contextualise them and put into use. According to the social scientist David Lazer of Harvard University, the ability to *measure* the evolution and strength of social relationships can "*revolutionise the field of social network analysis*". Advances in miniaturization of mobile and wearable technology provide various opportunities to log

dynamics in personal social networks in a non-obtrusive way:
- *Logging Physical Proximity*: dynamic patterns of physical proximity in a population can be logged with wearable devices explicitly designed for this purpose, such as the infrared-based sociometer (Choudhury et al. 2004). Moreover, it becomes increasingly feasible to use short-range radio-based techniques present in contemporary mobile devices for this purpose, like in Reality Mining (Eagle et al. 2005).
- *Logging Physical Location*: logging physical location and correlating the logs can be an indirect means to log proximity. Logging the physical location itself can provide insight into the relation between location and personal social network dynamics. Depending on the situation, it might be necessary to log locations with GPS-precision, but in some cases it may be sufficient to log the Cell-ID of a mobile phone network a mobile device is connected to.
- *Logging Communication*: frequency of communication, duration of the conversation and context in which the conversation takes place are very important parameters to determine users' communication patterns. In the past, this method required a lot of effort from the interviewee side, writing down communication diaries. Today the process is simpler and does not require user interaction; communication logs can be easily collected through communication loggers installed in the mobile device. An example of this approach comes from the ContextPhone (Raento et al. 2005a). On one hand, we have progressed in the measurement of social relationships, but on the other hand we have not done the same in providing the user with the possibility of using this valuable information in the various contexts of everyday life. The situation is slowly changing, and through our examples we have seen that applications such as Context Software already allow a degree of control of the user over her data.

For example, it is easy to observe that only Context Software supports all relevant classes of mobile relationships, and that the applications mainly aim at supporting person-to-person communication, without providing powerful tools for ad-hoc community building, group coordination, enhanced ambient interaction and control, personal productivity, time, information and social network management. Previous studies (Rettie 2003) show that each of us has to fight daily with a growing number of small tasks, which often cause interruptions to our current activity, and the process of managing and organizing information is taking more and more of our time; another study (Taylor et al. 2002) also identified the need of more effective contact management tools, but didn't receive yet much attention. Visualisation of the personal social network, based on criteria chosen by the user according to the context, could be useful to support a more efficient time and contact management, especially if linked to user's usage patterns and statistics. This approach has already been used in SmartFriends, an application for Smartphones developed by CLVE. It is also important to observe that the concept of '*identity*' in both social software and mobile social software often corresponds to the user profile, which might contain a description of the self, multimedia, comments of other users and some statistics of activity in the system. A study on Friendster users (Boyd 2004) shows that many people have multiple representations of the self, including fake ones, which might be created just to confuse the network. Sometimes people even "steal identities", create a representation of a real person, typically a friend who has no online profile, and start using it pretending to be that person in the system. According to the creators of Friendster, the so-called "*Fakesters collapse the network, devaluing the meaning of connections between people on the system*". This argument assumes that the network value is in trusted links. Unfortunately (for them), "*many users saw value in Fakesters, considering them little hidden treasures of creativity in the network*". This reveals the fundamental weakness of trust on Friendster, where anything can actually be considered as "*real*". Applying the same concept in mobile social applications, a similar approach could be used in creating profiles not responding to the truth in DigiDress. Of course, if the application is not used for serious purposes, this could be accepted, but in general a different approach is needed to embed identity and trust in social network applications. In "*The Augmented Social Network*" (Jordan et al. 2003), identity and trust are considered as building blocks of the next-generation of online communities, which will be overlapping with mobile communities. The authors suggest the concept of "*persistent identity*", which should support the values of a civil society in which citizens self-organize and are at the heart of a democratic society. The persistent identity is not simply a user profile or a list of purchase preferences, but a more complex set of data released by different parties:

- *A civil society digital profile*: represents an individual's interests and concerns that relate to his or her role as a citizen engaged in form of democratic governance. The digital profile should include the abilities of each individual and, from this perspective, is quite similar to a curriculum vitae approved by the institutions
- *Expressions of Affinities and Capabilities*: list needed to assist in the discovery of other trusted individuals who share these interests. The discovery could be left to automated agents which provide recommendations to the user
- *Introduction Protocols*: set of rules needed to establish connections between individuals who share affinities or complementary capabilities.

In addition, the persistent identity should evolve with the user's behaviour; potentially, every online choice made could contribute to modify the digital profile. Although the proposal of "*persistent identity*" seems quite utopian, it

presents interesting ideas, which could be used for improving the current services which rely on online representations of identity. The concept of trust in mobile environment has its obvious application in access to resources; it is a desirable feature to have the possibility to share any kind of information, but at the same time it is advisable to have also an easy tool to set access permissions to items (folder, kind of information, actions) according to level of trust with a specific contact or group. Most applications which adopt "*controlled sharing*", such as Context Media, give full control to the user to set the access permissions. On the other hand, this task also requires an effort, especially when the items to share are many. Furthermore, not only the situations are dynamic, but also the nature itself of human relationships. Trust can be achieved, but also lost, so friends in time could be classified as acquaintances, or group colleagues could be considered also friends. A possible solution would be to add to the "user control" over sharing also an automatic system of "*recommendations*", based on frequency of offline and online interactions and other parameters.

6. CONCLUDING REMARKS

In this article we gave an overview on the development of social applications to the mobile environment, which is still in its early stages, but presents a number of useful applications. Mobile social applications have been possible thanks to the progressive technological convergence of computer networks and mobile networks. However, there is not yet consensus over the definition of "*mobile social software*"; adapting Shirky's definition of social software to mobile environments, mobile social software could be defined as "a *kind of software that supports interaction among networked mobile users*". The definition seems to acknowledge the importance of the people who are socially interacting through computer networks. We analysed the kinds of interaction among mobile users according to Marti's class of relationships: user-device interaction, interaction between co-located users and technology-mediated human-human interaction. Five examples of mobile social software were taken into consideration and shortly presented, showing their peculiar features and limitations. Finally, we compared social software and mobile social software from system and user perspective, focusing on the some issues that are considered of crucial importance for the future development of mobile social software: identity, trust and user control of information flow.
In the future, we are planning to develop a taxonomy of mobile social software and to gain a better understanding of identity, trust and user control of information flow in mobile environments, in order to develop mobile services supporting communication, time and contact management and ambient interaction.

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