

CONTEXT-AWARENESS, THE MISSING BLOCK OF SOCIAL NETWORKING

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Social Networking Sites (SNS) have become increasingly popular with the rise of the Web 2.0 in which internet users are invited to contribute and interact on web sites. Although many SNS are criticized for privacy issues, most of their users tend to share more and more personal (and sometimes intimate) content on these communities. This creates new opportunities for them to communicate and exchange with their friends, acquaintances or even with people they are ready to interact with. In this paper, we explore how to gather and leverage user's context knowledge in order to ease and enhance the social communication experience in networking sites. In order to give a first illustration of our proposition, we also present our current works on hyperlocal communications as a transposition of the SNS paradigm to real life meetings and encounters. We rely on an analysis of several modern SNS and their new usages, a definition of context-awareness, and the current trends that motivate our approach.

Keywords: social networking; context-awareness; ambient intelligence; hyperlocal; meeting room.

1. Introduction

Composing a new kind of communication medium, Social Networking Sites are competing with older communication modalities, such as: voice (phone) calls, SMS messages, e-mails, and chat sessions. Whereas phone-based communications (i.e. voice calls and SMS messages) have been ubiquitous for years, new interaction paradigms

brought by SNS are not yet adapted to the context of users that are increasingly in a connected mobility. Firstly, most popular SNS are designed for an optimal experience on computers, and thus, require users to sit behind a computer to experience innovative kinds of (but virtual) social interactions. Secondly, the social network of users (and their new interaction paradigms) is static and manually maintained (i.e. like address books), whereas people have many opportunities to communicate in their daily life with people that are not part of their social network.

The aim of this paper is to demonstrate that real life social networking can be significantly enhanced in merging practices from SNS and context-awareness functions. After having introduced SNS and Context-Awareness in the following section, we analyze several modern SNS and their new usages in section 3. From this analysis, we identify in section 4 several opportunities to leverage users' context in order to improve their social communication experience with SNS. Then, in section 5, we present a short illustrating example of social application relying on one specific context: the Meeting Room Assistant.

2. Background

In this section, we introduce two foundations that are necessary to understand this paper: Social Networking Sites and Context-Awareness.

Social Networking Sites have become extremely popular on the Internet, with the rise of the so-called Web 2.0. It can be seen as the latest Internet-based communication medium, after blogs, instant messaging platforms and forums. A SNS is a virtual community in which users have a personal web page (called a "profile" or a "space") that allows others to know more about the interests and activities of the profile owner and to interact with him/her in many ways, mostly in a public fashion. The goal of each SNS is different, but in most cases, the social interactions involve people that mutually consented to connect as "contacts" or "friends" on the site. The notion of connection also has a different meaning depending on the site, but the fact of being recognized as a contact is usually required to enable most kinds of social interactions provided by these sites. As depicted on Figure 1, a user (A) can benefit from these rich interactions with the contacts (B, C and D) of his social network, whereas the only possible action between this user (A) and a person (Z) who is not a contact of his social network is to invite him/her by email to join his social network. These interactions include: personalize one's

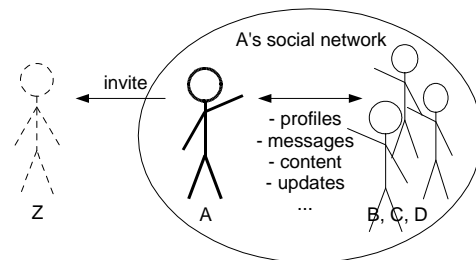


Figure 1: Social interactions in a Social Networking Site

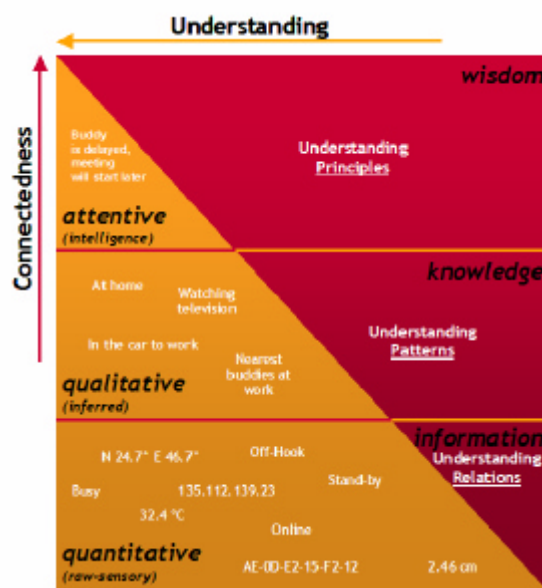


Figure 2: Levels of context

own profile, writing a public message to a contact's profile, commenting publicly a contact's photos, being notified of what actions were undertaken by one's contacts on the site... Here, the "public" visibility is often restricted to the recipient's contacts, but this constraint is not common to all SNS. In the next session, we will analyze the features and differences of several SNS among the most popular: Facebook, Myspace, Twitter and LinkedIn.

Context-Awareness is an area of Computer Science which deals with the adaptation of computing systems to the user's current context. Introduced by (Schilit, Adams, & Want, 1994), the most recognized definition for the term "context" was from (Dey, 2001): "Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves." By being "aware" of the user's context, a computing system can make deductions about the current situation of the user, from various hardware sensors such as GPS receiver (i.e. for positioning), surrounding Bluetooth equipments (and thus, surrounding people), and even software sources like one's agenda and list of currently opened documents. As shown on Figure 2, by combining and inferring on this sensed information, a meaningful knowledge can be derived, for instance position or activity like "in a meeting" or "watching TV" can be deduced. Most research projects leverage the context of users of a system in order to adapt the interaction between the user and the system (Christopoulou,

2008), or for the system to pro-actively make decisions intended to support the user (Wang, Dong, Chin, Hettiarachchi, & Zhang, 2004). Such applications include Intelligent Meeting Rooms (Leong, Kobayashi, Koshizuka, & Sakamura, 2005; Chen et al., 2004), Smart Homes (Gu, Wang, Pung, & Zhang, 2004), Personalized mobile advertisement (Zhdanova et al., 2006) and electronic healthcare (Broens, van Sinderen, van Halteren, & Quartel, 2007). In our case, we consider context as sampled information about people's environment and actions in time, and we propose to leverage this context information to give more opportunities for users to communicate with each other. The aim is not to adapt human-system interaction, nor to envision a pro-active system for user support, but to create links between people. Several context-aware social applications have been developed (Koolwaaij et al., 2006; Gaonkar, Li, Choudhury, & Cox, 2008), but the design of these applications was based on context-awareness (bottom-up approach), whereas we decided to rely on existing (and successful) SNS and their specific communication paradigm (top-down approach) in order to benefit from their user acceptance.

In this paper, we will explain how this contextual knowledge can be utilized to improve social communications.

3. Social Networking Sites, a State-of-the-Art

In this section, we compare the features of several of the most popular Social Networking Sites against regular communication mediums.

3.1. Meaning of relationships

Like popular instant messengers (e.g. Windows Live Messenger, Yahoo! Messenger, ICQ), SNS users have to invite their contacts on the platform to enable proper communication. On one of the first social networks, classmates.com (1995), your contacts were people you have actually been in school with. But, ten years later, the well-known SNS Myspace.com (2005) which was reportedly getting more page views than Google (Rosenbush, 2005), built its popularity on a weak meaning for "friendship" connections. Indeed, on this site, most "friends" (contacts) had actually never seen each other in real life. It is also usual to see a celebrity in one's friend list. Indeed, Myspace has become the best place for teenagers to boost their social ego, and for artists (and brands) to show off their content and get closer to their fans. With Facebook.com, Myspace's biggest rival, the meaning of "friend" seemed more natural, as it was originally intended for students of Harvard College to keep in touch. With time, its population grew out of Harvard to seduce students and workers around the world. But still, it seems that most people that connect with each other on the site already knew each other before in real life (Nicole B. Ellison, Charles Steinfield, & Cliff Lampe, 2007). Indeed, a study (C. Lampe, N. Ellison, & C. Steinfield, 2006) proved that this kind of SNS is more used for "social searching" (i.e. look up already known people) than for "social browsing" (i.e. find strangers online). The same trend seems to apply on the popular professional SNS LinkedIn.com, although some people gather as many

professional contacts as possible to increase their visibility to potential employers and/or collaborators. In Twitter.com, which we will further describe below, the contacts are called “followers” who chose to be notified of one’s last social updates in real-time, even though anyone can actually read them. Whereas connection as “contact” or “friend” requires a mutual approval on most SNS, twitter does not.

We have seen that SNS rely on connections between contacts, but the meaning of these relationships differ from a SNS to another. In every case, however, a connection is to be declared explicitly, by consulting a user profile, searching for a person or responding to an invitation.

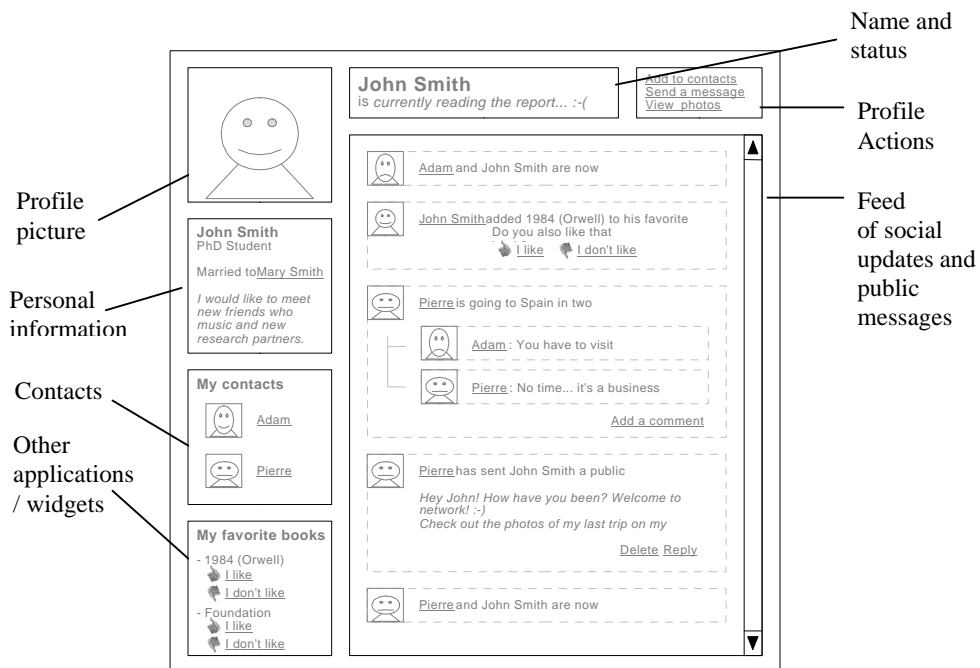


Figure 3: Typical user profile in Social Networking Sites

3.2. User profile enhancement

On former SNS (i.e. classmates.com), user profiles were structured in a specific manner, usually by filling predefined fields. A major reason for the popularity of Myspace is the possibility for users to personalize deeply the appearance of their profile page with HTML and CSS code. With a little bit of hacking, anyone could feel more unique, not only with the content but also with the style of their profile, making it more attractive to get more friend requests, and thus appear to be more popular. On most other SNS, users

were invited to personalize their profile with pre-defined styles or controlled choice of colors, media and fonts. The biggest step in this domain was made by Facebook in 2007, when they opened their website as a platform for externally-developed add-on applications (“Social graph-iti,” 2007). These applications can appear as public widgets on the user’s profile, leverage his/her community and integrate new social interactions in the facebook interface. For example, as depicted on Figure 3, a social application about users’ favorite books can display a widget on the user’s profile in order to show off the user’s favorite book to the user’s contacts, and to invite them to interact about these books (e.g. rating books). This innovation made Facebook become more popular than Myspace for the first time in 2008 (Beky, 2008), showing that it is the diversity of applications (and thus, new social interaction opportunities) which attracts users on SNS. Since this evolution, most competing SNS have turned into social applications platforms like Facebook, allowing third-party applications to leverage the user’s community in order to enrich its social experience. This trend gave birth to several collaborative initiatives such as OpenSocial (“OpenSocial”), which defines a common API to build interoperable applications on compliant social platforms, including LinkedIn. Note that Facebook has not joined this project, so they keep full control on their API.

Besides the addition of content brought by third-party social applications on user profiles, we will discuss some of the new interactions modalities implied in the next paragraph.

Table 1: Typical interaction modalities on Social Networking Sites

| Interaction | Recipient(s) | Visibility/ notification | Intention(s) |
|--------------------------|---------------------|-----------------------------|--|
| Profile message | Contact/own profile | Public (all contacts) | <ul style="list-style-type: none"> - Introduction of a newly added user - Public display of interest/affection, or recommendation of the recipient (e.g. business) - Let the recipient’s contacts know what’s going on between them |
| Bulletin/ Posted item | Contact/own profile | Public (all contacts) | <ul style="list-style-type: none"> - Share interesting content with contacts - Announce an important event to all contacts - Request feedback from contacts |
| Gift | Contact | Public (all contacts) | <ul style="list-style-type: none"> - Public display of interest/affection, with more impact than a profile message, because gifts are usually not free |
| Events (invitation) | Contact | Public or Private | <ul style="list-style-type: none"> - Invite (some) contacts to an event - Enable communication between attending people (e.g. for arranging a common gift, adding contacts) - Share content related to the event (e.g. photos, videos, links) |
| Groups | Contact | Public or | <ul style="list-style-type: none"> - Gather people around a same interest or |

| | | | |
|-----------------|------------|---------|---|
| (invitation) | | Private | cause to enable communication about it - Opportunity to add contacts |
| Poke | Any person | Private | - Say “hello, check out my profile” to someone probably just met in real life (less formal than a connection request) - Temporary inclusion of the recipient in the sender’s contacts, allowing visibility of his/her profile and rich communication |
| Private message | Any person | Private | - Have private interpersonal discussions (no particular interest for social networking) |

3.3. *New social interaction modalities*

In this paragraph, we present several interaction modalities listed in Table 1, which were introduced by SNS and their add-on applications. The most common feature is public profile messaging. This feature was metaphorically called “wall” by Facebook. It allows to turn a simple message into a public announcement or display of affection, allowing friends to know what is happening in their community. This modality has been appropriated by users to create new rituals. The most respected ritual is to respond to a connection approval by sending a public message “thanks for the add” on the recipient’s profile page. This is a good way to show the recipient’s contacts that there is a new contact onboard, advertise, in the case of an artist or a brand, and also to recommend the recipient to the people who consult his profile (e.g. for business networking).

SNS also allow users to advertise bulletins to their community. A bulletin (also called “posted item”) is an announcement or message that will be listed on every contact’s bulletin listing. It is a good way for artists to announce new material, and for other people to spread good/bad news, general questions and even jokes. It can also be used as an incentive to gather feedback from contacts.

One can also buy a “gift” to someone, which eventually appears as a small image on the recipient’s profile, with the name of the sender. As silly as it may seem to pay for sending a small image to another internet user, it is actually seen by users as a distinctive sign of affection, as this “gift” cannot be duplicated to other contacts without paying for it again.

Creating “events” and inviting contacts to them is a good way to announce this event with practical (and possibly targeted) information such as their location, time, and motivations to attend. Because people are invited to respond whether they are going to attend or not (or maybe), it gives the opportunity to communicate with attending people (e.g. for arranging a common gift because a party, or to keep in touch with new friends made during the party) and with indecisive people (i.e. to personally insist with good reasons to accept the invitation). An “event” can also gather and hold content related to this event (e.g. photos, videos, links...) to all participants.

A social network can hold several communities which are interested in specific subjects or causes. By joining a group, one has the opportunity to integrate conversations

that are related to the subject of this group, possibly with people that are not part of his/her contacts. This can lead to connecting to some of these people.

Despite the strong meaning of “friend” given to Facebook contacts, one can “poke” another if he/she is interested in contacting that person without bothering for a “friendship” request. This “poke” is a notification that also allows the recipient to browse the profile of the sender without restriction, like if they were friends.

Other interactions include social tagging of people, comparison and matching of user preferences (e.g. favorite movies, music and books) and quizz results, and games (e.g. poker). Of course, it is also possible to send private messages, but this communication modality shows no interest for social networking.

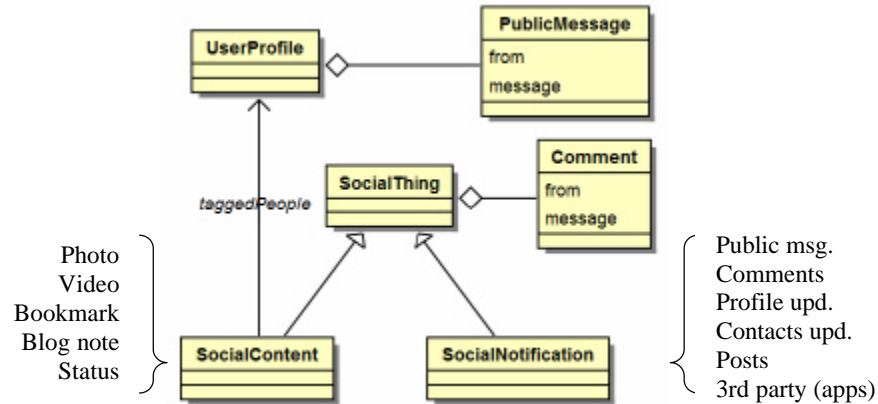
3.4. Feeds of social updates

One of the novel concepts brought by SNS is the publication of social updates. The pioneer in this domain is Twitter.com, launched in October 2006. On this website, users are invited to answer the question “what are you doing?” from time to time with a public answer that is limited to 140 characters. It is possible to send such updates from anywhere by SMS, and to receive updates from “followed” twitter users also by SMS, which turns this SNS into a simple mobile SNS that works with any mobile phone without internet access. It happens that this innovative service was used in thousands of ways that it was not designed for: to advertise websites, share opinions and moods, spread news and even earthquakes notices (Mischaud, 2007).

Facebook’s appropriation of this concept didn’t have much success at the beginning (Arrington, 2006; Gruber, 2006) for privacy reasons but eventually became a must for SNS. On their feed listings, Facebook would not only list the 140-characters-long updates typed by contacts but also present the last events and interactions related to one’s community, including marital status changes, new public messages, but also application-specific notifications. Now that Facebook users know that they can restrict the notifications being sent to their contacts’ feed to protect their privacy, it happens that it is actually a powerful social feature. It allows one to have a social feeling of what is happening in the community without having anybody to advertise it explicitly, and it helps spreading information in a viral fashion.

3.5. Many opportunities to communicate

Even though spontaneous messages are the most simple and universal way of communicating, SNS also provide many other opportunities to communicate. Indeed, it is possible to comment almost every piece of information on a SNS, including photos, videos, bulletins and even quizz results for example. Like on blogs, comments are a great way to communicate with someone in a specific context in which we assume the recipient to be interested (i.e. because he/she is the one who posted the piece of information that was commented). Of course, new comments are also considered as social interactions, and thus they can be advertised on the feeds of every contact of the sender’s community, according to the privacy preferences set by the users. It also means that a comment can



lead to other comments from other people, giving birth to a discussion. On Facebook,

Figure 4: Simplified model of SNS communication

comments can even be posted on status updates.

As depicted on figure 4, we can generalize SNS communications in a simple model in which the main conversational classes are *PublicMessage* and *Comment*. The user profile holds public messages, whereas social content and notifications hold comments. Both of them define a starting point for human communication. Whereas social content is manually entered by the user, notifications are generated by the platform and its applications from socially-relevant interactions. Social links are provided to the author of every message and comment (through the *from* attribute), and they can also be added on social content which is related to them (e.g. photos in which they appear) through the *taggedPeople* relation. This explicit link gives a good reason to notify people when content is posted about them, which leads to a good probability to get a response from them (e.g. to comment a photo on which they appear).

In this section, we have seen that SNS are powerful social communication platforms with several different communication modalities relying on the viral spreading of social content, interactions and updates. Nevertheless, the big enthusiasm generated by SNS has led to a productivity issue which made many companies restrict access to SNS. The paradox in that matter is that several initiatives are translating the SNS paradigm to enterprises in order to improve corporate knowledge management and sharing through participation of their employees. Indeed, SNS are a potential killer application to boost productivity and fulfillment of professionals, but they are too much time consuming yet, since every piece of information to spread has to be entered manually. In the next section, we will discuss opportunities to reduce this time loss by leveraging contextual information sampled by sensors.

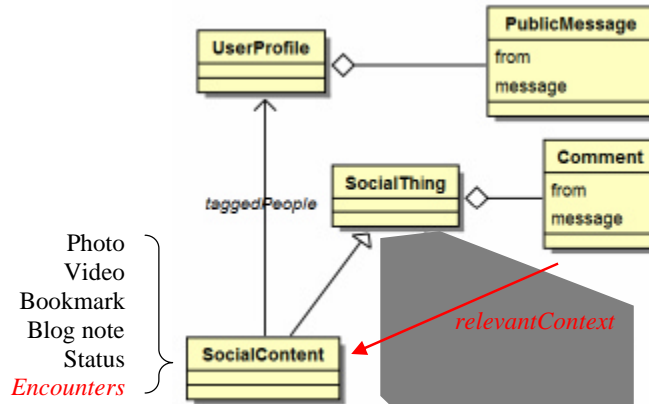


Figure 5: Considering context in the SNS communication model

4. Towards context-aware Social Networking Sites

As we have seen in the previous section, SNS have become very popular and they bring exciting social communication opportunities as people start to share content and personal information on them. Sharing is important because it is a starting point for communication. However, sharing can be more time consuming than the communication itself, which is a major productivity issue, especially when intending to translate the SNS paradigm to the enterprise. Another point that we have expressed in the previous section is that most of the communications occurring on SNS rely on comments and tags responding in context to these shared content items.

Overall, it appears that the most communicative value is in the comments. As shown with the “relevantContext” added on Figure 5, these comments are posted to respond to a context represented in a shared content (i.e. the shared content can be a picture, a link or a personal status like the user’s location or activity) which was manually entered. Furthermore, the management of contacts lists, which are essential to frame a specific population when sharing content, is a time consuming task without communicative value.

We deduce that, in order to reduce the burden of maintaining one’s own social network while optimizing its communicational benefits, these tasks should be automatized, or at least assisted: sharing of content representing a context and management of contacts lists.

4.1. Assisting SNS content sharing with context information

As briefly introduced in the “background” section, context-awareness consists in sampling information about the current context of users in order to deduce their situation: where they are, what they are doing, who they are with, and so on. We believe that sharing some of this information can replace, or at least assist, manual entry of shared

contextual artifacts (e.g. a photo, a link or a personal status) that are socially useful to start communications, so that the user can focus on the communication instead of the trigger of this communication. In this part, we propose several examples of use cases in which SNS users would benefit from this assistance, and discuss briefly their technical feasibility with off-the-shelf technical solutions.

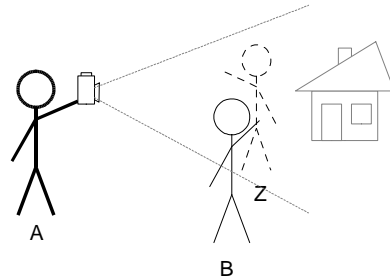


Figure 6: The photograph's Use Case

As an example, and as illustrated on Figure 6, we consider the situation of a user (A) taking a picture of his friend (B) with the friend (Z) of his friend. With current SNS, the user (A) can show this picture to his friends by posting it on their SNS. At this stage, just his friends (including B) will be notified of this new picture. In order to make this picture visible to his friends too (including Z), user B has to “tag” himself on it (i.e. to declare that he appears on this picture). Then user Z also has to be tagged on this picture in order to show it his friends. This process becomes tedious when more people appear on a same picture, and when dozens of pictures are posted at once. Our proposal to improve this process is to automatizing the “tagging” of people appearing on this picture, thanks to their mobile phones. Assuming that each of them carry their personal mobile phone, we can sample the close proximity between them as contextual metadata of the picture. Then, a mapping between the mobile phones’ unique identifiers and the profile of their owner on the SNS is sufficient to add “tags” automatically on the picture when it is posted on the SNS. This automation reduces the burden of manual annotation of the picture by the photographer to spread the picture to the relevant audience, and thus increase the chance to trigger conversations, as its visibility is granted to more people (user A’s friends, user B’s friends and user Z’s friends). This Use Case is already feasible for a wide audience using the Bluetooth wireless technology which is embedded in most modern mobile phones.

As another example, we observe that knowing whether a person has just traveled to another city is an interesting information for a contact who has already been there to propose recommendations related to that location: e.g. museums to visit, good restaurants and other local tips. Entering this location information explicitly, if the user ever does it, can be annoying. With the support of a context-aware infrastructure and its required sensors, this information could be shared to the person’s social network automatically, bringing opportunities for the community to share their recommendations (and thus communicate) in response to that contextual notification. Several technologies embedded in modern mobile phones, such as GPS and other beacon-based positioning, can provide such contextual information. This use of this context information can be translated for various social scenarios: e.g. contact proximity notification, activity proposal, trip planning assistance and many other.

We are still in the process of identifying new use cases in which we believe that SNS-like interactions would be supportive. The enabling technologies to rely on will be implied by the contextual constraints and specificities of these use cases. Thus, we choose to focus our research on people and their communications, instead of pushing specific technologies beforehand.

4.2. *Assisting SNS contact list management with context information*

In SNS, becoming contacts (often called “friends”) can seem similar to exchanging phone numbers, as it is an explicit action. Nevertheless, whereas one’s phone number can be transmitted to someone without the owner’s agreement, becoming his/her contact on a SNS is a mutual operation that requires approbation from both parties. This mutual agreement enforces the protection of privacy in such that contacts are granted additional communication and personal information visibility rights with each other’s profiles on the SNS. In order to add someone as a contact, the requester needs to know his/her name and other information to make sure that the “profile” being added as a contact is actually owned by the expected person.

In some situations, it would be valuable to enable rich communication modalities with people one doesn’t necessarily know much about (i.e. too less to request connection in an SNS), but are part of the same context (e.g. doing a similar activity in close vicinity, be in a same place). In that case, the relation between two people is their common context, not a proof that they know each other (e.g. their name). This common context is an opportunity to communicate, like sharing content on a SNS. This means that every time one enters a place which holds other people, these people might enjoy to leverage SNS-like interactions (e.g. profile browsing, instant messaging, bulletins, gifts...) to start and enhance in-real-life communication.

In our current works, we strive to demonstrate that context-awareness is valuable to automatize or assist the sharing of contextual updates in SNS. Hence, instead of spending precious time to manually share the content for triggering communication, the user can focus on the purely human communication – within or without the SNS – in which all the social value of social networks reside. In the next section, we briefly introduce the “Meeting Room Assistant”, an application of hyperlocal social network which illustrate how context-awareness can seamlessly bring the benefits of SNS to real world meetings.

5. Meeting Room Assistant, a hyperlocal Social Network

Above, we suggested that the SNS communication paradigm might be beneficial in real world social situations. A typical example of such situation can happen in meetings and other social gatherings: people meet in a given place for a given reason, and they have to communicate with each other without necessarily even knowing their names or their roles. In this situation, browsing “profiles” of people and exchanging files with each other can be helpful, but the current paradox is that these kinds of actions are actually easier when people have virtual meetings than in face-to-face meetings.

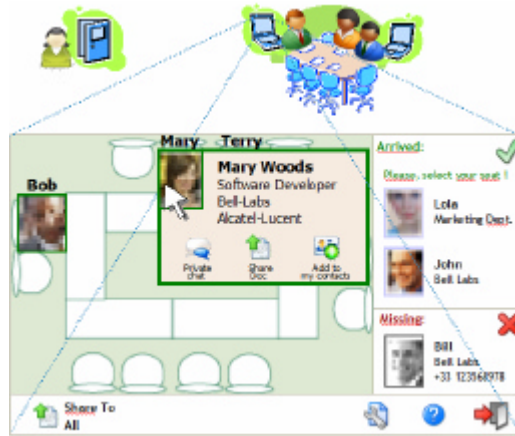


Figure 7: Graphical user interface of the Meeting Room Assistant

In our “Meeting Room Assistant” prototype of the “Hyperlocal Communication” project, we are experimenting the enablement of SNS-like communication modalities in a face-to-face meeting situation. Hence, this first prototype’s design is applied to the context of a specific place (i.e. meeting rooms) and activity (i.e. business meetings). The idea is to provide access to a private SNS session to the meeting participants, through the use of any networked terminal with a screen and an input interface (e.g. a laptop, a PDA, or a smartphone). In order to integrate the meeting participants into their actual meeting session (i.e. their common context), they swipe their personal card that holds a vcard with some identification information (e.g. their email address, name, photo, position or roles) into a NFC (Near-field communication) card reader at the entrance of the meeting room. As soon as they swipe, they receive an email that links to the hyperlocal SNS representing the meeting room and its positioned participants. Figure 7 shows the graphical user interface of the Meeting Room Assistant, on which photos of participants (Bob, Mary, Terry, Lola and John) can be moved on the room’s map to match their actual position. As automatically connected SNS contacts, participants can view the profile of others, communicate with each other using several modalities (e.g. public, group and private instant messaging) and exchange documents. When the meeting is over, the participants can still open this SNS session to find participants’ contact information, the message logs and the documents that were exchanged during the meeting.

Our “Meeting Room Assistant” prototype has shown the usefulness of SNS-like social communications in a common situation, in which contacts are connected without having to require explicit and mutual approbation of a “friendship” relation, thanks to the context-awareness of our system. We intend to experiment hyperlocal SNS applications in different social situations in order to evaluate the acceptance of users for this kind of enriched (or augmented) real-life social communications.

6. Conclusion

In this paper, based on an analysis of usual features of modern Social Networking Sites, we have identified several opportunities to improve the social communication experience of users by bringing context-awareness into these SNS. Assuming that social communication is triggered by sharing contextual artifacts such as content or personal information, we proposed to leverage context information to assist this sharing, allowing users to focus on the communication instead of the sharing process. With this assistance, we intend to increase social awareness, and thus trigger more communication between people while not requiring them to spend more time on SNS. We also introduced the concept of hyperlocal communications, translating the SNS communication paradigm to face-to-face encounters of unrelated people, in the “Meeting Room Assistant”. In this meeting situation, the communication of participants is enriched (or augmented) with SNS-like interactions without the burden of “social searching”, sending “invites” and requesting “friendship”.

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