Signaling in Mobile, Social Computing: Analysis and Design

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Spring 2005
Techo-Identity Seminar

Introduction

We live in a world where the distinction between online and offline interpersonal relationships is often becoming blurred to the point of inseparability. Traditional organizations have found that an online component can play a significant role in membership relations. Similarly, social organizations that have their roots in the virtual are moving out into the physical world. In this essay, we examine examples of social computing systems that leverage mobile computing to form hybrid social organizations, which incorporate features from both their online and offline counterparts. We then propose our own system that aims to incorporate the strengths of its physical and virtual progenitors.

Background

Not long ago, these two spheres – the physical and virtual – co-existed in seemingly parallel planes where one seldom had implications for the other. Judith Donath's 1996 essay, "Identity and Deception in the Virtual Community" referred to a New Yorker cartoon entitled "On the Internet, No One Knows You're a Dog" to highlight the nature of this relationship. To be sure, many forms of virtual organizations still operate divorced from the physical realm: online auctions, gaming, and chat are just a few of such systems.

However, much has changed in the last ten years. The rise of social networking sites is playing an important role in the process of digitizing our everyday identities and social roles into a format compatible with the online world. Sites like Friendster and LinkedIn allow people to explore the social landscape, primarily established offline, from an online interface. Dating sites like Match.com are used with the express intention that relationships made over the Internet will lead to face-to-face interactions.

Going forward, mobile computing is poised to make the confluence of physical and virtual organizations a reality. Using modern smart phones and PDAs, people are staying

online as they go about daily business; the world of the computer desktop is now available to us out in the physical world. Mobile technology is with us nearly wherever we go and whenever we meet someone. New relationships are often made concrete by the exchange of digital contact information in the form of telephone numbers, email addresses, and instant messaging user names. As mobile interfaces become more useful, it will be increasingly easier to blend together online and offline activities into a seamless flow of interaction and communication.

Dimensions of Analysis for Mobile, Social Computing

Any organization, be it traditional, virtual or a hybrid, has an organizational structure. The structure dictates, among other things, how information flows between members and who has the power to affect the organization as a whole. Democracies may be considered flat in spirit with a minority of people being chosen to coordinate the will of the masses. Corporations may be strictly hierarchical where power explicitly flows from the top down. Social networking sites may have a more graphical organization where certain people act as hubs and enable less central people to network through them. LinkedIn enables a Silicon Valley venture capitalist to function as a connector while a recently graduated engineer might be more of a leaf node. We can categorize new forms of social systems by the classes of organizational structure that they support.

Social organizations and their members need not have a static organizational structure. Citizens in a democracy may go on one day to become a president – no matter how unlikely the possibility. An entry-level mail clerk may go on one day to become a Chief Executive Officer. Future chess Grandmasters build up their ratings by playing as amateurs and progressing up the hierarchy. While an evolving structure might always be desirable, one can characterize a new social computing system by its support for a dynamic structure.

Different social systems have different membership criteria. Anyone who has a computer and the Internet can participate in Usenet discussion groups, but it might take a personal

connection to get entrance to a popular club scene on a Friday night. What are the pre-requisites for participation in emerging social computing systems? Beyond the rules that that are imposed by the system itself, are there specific hardware, software, or services that one must have in order to use the system?

Members of social organizations often signal to members and non-members alike about their affiliation. In traditional, social organizations, this can take the form of business cards with company seals, class rings from a university, baseball caps bearing logos, tattoos with gang insignias, and T-shirts acquired at specific events. Virtual organizations have similarly functioning devices such as graphical icons that might indicate membership in a web ring or compliance with specific standards bodies. These signals are used by others to assess the underlying quality of relationship that the signaler has to the indicated organization. What are the signals emitted in these new systems, and what qualities are they used to assess?

Beyond showing membership, these public displays of affiliation can signal about levels of status and influence within the organization. Rank in military organizations can be ascertained by studying the marks that a soldier wears on his uniform. In online games, such as EverQuest, players who have achieved high levels of skill are easily identified by their possessions including armor and weapons. These brandished items have a high cost associated with them, which is incurred by spending the time and effort to acquire them, and function as reliable signals of the players' status. How is status and rank signaled in mobile, social computing systems?

Existing Mobile, Social Computing System Analysis

We evaluate three mobile, social computing models along the lines outlined above. These three systems are TXTMob, Familiar Strangers, and Serendipity, and a matrix breakdown of their differences is provided in Table 1. While each serves a different purpose, they all fall into the hybrid category of social systems that have both physical and virtual components.

System 1 – TXTMob

TXTMob is a text messaging service designed to help physically distributed users coordinate and share information during large-scale events.[1] Created by the Institute for Applied Autonomy and maintained by Tad Hirsch of the Computing Culture group at the MIT Media Lab, TXTMob has been successfully deployed in all over the world. Perhaps most notably, TXTMob was used in New York City to aid protestors at the Republican National Convention in 2004.

In order to become a user of TXTMob, one must create a user name and submit a phone number along with carrier information to a website. Once this is done, a text message is sent with a verification code that activates the account once entered into the website. With an active account, users are free to join groups or create groups of their own. As a member of a group, text messages that are sent to the group are forwarded on to all members. Three different types of groups are specified. Public groups are open to any TXTMob user to join. Users can select these groups from the list of all groups and join instantaneously. Private groups are similar to public groups in that they are listed in the main directory on the TXTMob website, but the difference is that a membership request must be approved by the group administrator in order to become valid. Secret groups are private groups that one can only join by invitation. These secret groups are not listed in the main directory.

TXTMob makes text messaging into a many-to-many technology. Users may signal to each other through the choice of user name, group affiliation, and the content of their messages. The text message content is perhaps the most important of such signals and indicates the signaler's knowledge of and connections to the event at hand. Deceptive signaling is made possible due to the large cost for receivers to assess the validity of message claims. The social organization of text mob groups is nearly flat, with the role of administrator or moderator providing the only semblance of hierarchy. The multiple

[1] http://www.txtmob.com

types of groups provide some variety, and the web interface for adding members allows group constitution to change over time. TXTMob does not afford a way for members to signal group membership to non-users.

System 2 – Familiar Stranger[2]

In the 1970's, Stanley Milgram defined the concept of a "familiar stranger" as someone whom one has never interacted with but repeatedly observed. Researchers pushed this idea further with their own Familiar Stranger project where people used a mobile device, called a Jabberwocky, to navigate their social surroundings. The key idea of the project is that these people whom we are surrounded by in our daily activity, but do not talk to, play an important role as a buffer between our friends and complete strangers. The goal of the project is to create an interface that lets the user be more attuned to this category of people while preserving its characteristics.

The Jabberwocky device consists of a Berkeley mote with a three LED display and two buttons. When another Jabberwocky comes into proximity, the red LED will increase its blinking rate if the other device has been seen before. The user has the ability to put the proximate devices into either the blue or green categories by pressing on one of two buttons. Once this is done, the next time the proximate Jabberwocky appears, either the green or blue light will blink respective of which button was pressed. These categories do not have previously assigned meaning, and the user is free to use them how she likes.

The Familiar Strangers project acts somewhat like a memory prosthetic device; the Jabberwocky remembers every user who has come into proximity over the lifetime of its use. No functional connections are maintained between users through the system, but people reliably signal that they possess the quality of "familiarity" through the blinking that the receiving unit exhibits when they come in proximity. The ability to deceptively signal this quality is made quite low by the difficulty of deceiving the Jabberwocky hardware. The presence of a device that blinks for all to see emits an additional signal

[2] http://berkeley.intel-research.net/paulos/research/familiarstranger/

from the device bearer that says that she belongs (or not) in her current social setting. This also functions as a type of display of status where one can impress users and non-users of how sociable they are. Each device maintains two user-defined groups as well as one super-group that monitors all device encounters. These groups have a flat structure, and have the potential to be quite dynamic based on the changing social environment.

System 3 – Serendipity[3]

The idea of using proximity to promote "serendipitous" encounters between well-matched people is not a new one. Systems such as the Lovegetty have used this technique for years. However, Nathan Eagles' Serendipity project, which is one part of his larger Reality Mining project, provides a current and familiar instantiation of the idea that lends itself to analysis.

The basic idea of Serendipity is that registered users of the system create profiles that include their Bluetooth ID's, phone numbers, and personal interests and expertise. As members of this online service come into proximity with each other, their phones send a message back to the Serendipity server with the Bluetooth ID of the other person's phone. The server then runs a matching function on the two profiles, and if there the algorithm determines that an introduction should be made, the system sends notifications to both the users' phones over MMS making the introduction.

Serendipity enables users to signal their interests to like-minded users while minimizing exposure to others. These signals are not necessarily reliable since the user is free to enter in whatever she wants as interests in her profile. This makes deception relatively cheap, and it would take a large amount of effort on behalf of the receiving user in order to determine the dishonesty. Serendipity's organizational structure consists of a graph of users with edges between people that a user lists as friends as well as the successful connections that are made through the matching algorithm. While currently not supported, it seems logical that the social network built up over time would be used to

[3] http://www.mobule.com

introduce people with close network distance in addition to common interests. At that point, high status might be associated with those who live in densely populated areas and have a common set of interests that people look for.

Proposed Mobile, Social Computing System

We propose a mobile, social computing system that would enable both physical and digital signaling about membership in virtual, graph-structured organizations. This system would formalize the act of transmitting and receiving signals of membership status for the purpose of building edges in the organizational structure. This would be accomplished by translating the cost paid by the signal receiver and the penalty imposed upon an exposed, deceptive signaler into asymmetric relationships within the organization. The resulting directed graph that forms and changes over time would define the channels of information flow through the organization. The implication is that a person with many edges flowing in would enjoy a more powerful or prestigious membership than the person who exclusively functions as a feeder of information.

The signals of social association afforded by the system would take two forms: iconic representations made visible on a wearable display and digital transmissions of membership claims from one system to the other. The envisioned wearable display might consist of an E-Ink embroidered shirt, capable of display animated or static icons on demand. The organization icons might be recognizable like baseball team logos, corporate logos, school seals, etc. However, they could also be icons that are recognizable only to people who are privy to their meanings. The underlying digital membership claim would be simultaneously broadcast to surrounding systems over some form of RF, such as Bluetooth.

The system would make it equally easy to emit both honest and deceptive membership signals. That is, both certified members of a group and mimics would be able to display the icons and transmit digital claims of association. Instead of going to a web site or using an official interface to apply for membership in a certain organization, one need

only assume such status and start signaling such a quality. The underlying assumption here is that full membership information about the organization is unknown to any one member. Members only know about their first-degree connections and those that are transitively known down paths of influence.

Two methods would exist for receiving and processing these signals. The default method would be visual; everyone around would see that the wearer is emitting the organization icon. People may choose to take this at face value. If they do not, they can use a second, potentially more costly, method to evaluate the signal. They may challenge the signaler by submitting the received digital claim of membership along with their own association with the organization, if they have one, to an unbiased challenge referee, which would be an autonomous agent associated with the organization. If it turns out that the emitter is below the receiver in the group hierarchy, then the emitter would be added as a subordinate of the challenger within the group. On the other hand, if the emitter is actually higher than the receiver in the hierarchy, an edge is made the other way. The full outcome possibilities are listed in Table 2. This second evaluation method would function as a way to organically grow the group and establish a hierarchy.

The proposed mobile, social computing system uses the signaling process as a way to continuously redefine the structure of an organization. The cost associated with assessing a signal and punishing deceivers serves to grow the social organization. With the addition of deception by members as to the rank that they possess in the network, one could further refine the quality of edges between nodes. This proposed system has similarities to games such as poker, where hidden state allows players to assume risk in the form of bluffing with the possibility of reward.

Conclusion

We have presented and analyzed three current examples of mobile, social computing systems. Each system has a different intended purpose but exemplifies a new generation of hybrid organization that incorporates both physical and virtual design considerations.

We then proposed a new system that falls into this same category but adds a new twist by making the signaling process explicit for the purpose of organically growing the social organization.

	TXTMob	*Familiar Stranger*	*Serendipity*	*Proposal*
Signals (and underlying Quality)	Messages with group-relevant information (Value to the group as an information source)	Co-presence that results in blinking lights (Shared experiences)	Introduction made when in proximity to matched users (Common interests and openness to communicate)	Visual display of membership in the same networks (Shared sense of identity)
Unchecked Deceptive Signaling	High, by texting false information with large assessment cost	Very low, enforced by hardware	Medium, with false profile entries	Low, false membership claims result in low status
Hardware Required	Cell phone	Jabberwocky (small electronic device)	Bluetooth Smart Phone	Bluetooth Smart Phone / Wearable Display
Interface Style	Interruption Based	Ambient to Intentional	Interruption Based	Ambient to Intentional
Foci-based networks	Yes	No	Yes	Yes
Network Structures Supported	3 Types of Groups (Public, Private, Secret)	Ego-specific groups with 2 user-defined and 1 general	Dyadic links	Directed, acyclic graphs
Edge Creation	Web-based / potentially using SMS, administer support may be required	Built up by proximate encounters and resulting device input	Web-based specification of profile and known friends	Challenges between users

Table 1. Analysis of three existing mobile, social computing systems and one proposed system.

	Receiver is not a member	*Receiver is a low ranking member*	*Receiver is a high ranking member*
Emitter is not a member	Draw: both added as members with bi-directional edge between them	Receiver Wins: Emitter added as member with subordinate link to Receiver	Receiver Wins: Emitter added as member with subordinate link to Receiver
Emitter is a low ranking member	Emitter Wins: Receiver added as member with subordinate link to Emitter	Draw: bi-directional edge created between Emitter and Receiver	Receiver Wins: Subordinate edge created from Emitter to Receiver
Emitter is a higher ranking member	Emitter Wins: Receiver added as member with subordinate link to Emitter	Emitter Wins: Subordinate edge created from Receiver to Emitter	Draw: bi-directional edge created between Emitter and Receiver

Table 2. The full outcome possibilities of membership signaling challenges made in the proposed mobile, social system.