Look Who's Talking

Mechanisms for Sharing Interpersonal Context
and Social Titles as Awareness Information

by

Matthew Graham Adcock

Submitted to the Program in Media Arts and Sciences,
School of Architecture and Planning
in partial fulfilment of the requirements for the degree of
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Abstract

Mobile awareness systems aim to convey personal context information between people in a way that is less intrusive, somewhat automatic, and often much more persistent than a phone call. Although there are many ways in which awareness information can be useful, the privacy of the individual can become more of an issue as more information is made available. Prototype awareness systems developed to date have therefore often been aimed at familiar cliques.

In this thesis proposal, we introduce a mobile address book based awareness system called Look Who's Talking (LWT) that aims to transcend the user's various social settings and social groups. Among its novel features is the ability to grant 'episodic access' to the device owner's context information in circumstances where their day-to-day access settings do not suffice. This is achieved by way of an SMS-like message called a LookAtMe. LWT also introduces a new type of awareness information for communicating aspects of the user's social attention (called Social Titling). Additionally, the system has a user interface that is geared towards mobile use, including mechanisms for on-the-fly input and a glanceable summary of incoming awareness information.

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"Let us say that in the ultimate, whenever a baby is born anywhere in the world, he is given at birth a number which will be his telephone number for life. As soon as he can talk, he is given a watchlike device with 10 little buttons on one side and a screen on the other. Thus equipped, at any time when he wishes to talk with anyone in the world, he will pull out the device and punch on the keys the number of his friend. Then turning the device over, he will hear the voice of his friend and see his face on the screen, in color and in three dimensions. If he does not see and hear him he will know that the friend is dead."

Harold Osborne, then recently retired Chief of Engineering for AT&T, 1954

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Chapter 1:
Introduction

The explosive uptake of mobile phones has transformed the way we interact with each other. We are no longer limited to meeting face-to-face at predetermined times, or having to find specific fixed devices in order to communicate electronically. The mobile phone has become a very personal device and is increasingly associated with its owner's activities in the world.

With this flexibility also comes a new challenge of uncertainty. Previous research has shown that people often describe aspects of their current situation such as location and activity when talking on their mobile phone [19, 31, 56, 55]. While actively calling someone to self-report or request one's context is one way of conveying this information, an alternative is to use a system that automatically shares awareness information.

Awareness[1] information is that which enables us "to remain sensitive to each other's conduct whilst engaged in distinct activities" [25]. Awareness systems aim to provide this information in a way that is less intrusive, somewhat automatic and often much more persistent than a phone call. In other words, awareness systems trade direct and dynamic conversation for more casual opportunities of use and a reduction of effort.

Since the initial articulation of the usefulness of awareness information by Dourish and Bly [22], researchers have identified a growing number of benefits of these kinds of systems. More recently, observations of SMS usage and prototype automatic awareness systems have given greater insight into the ways in which people can derive benefit from awareness information. These include interruption avoidance [40], parallelised social

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[1] As awareness information is often used in communication systems to infer the presence within that system of a potential communication recipient, the term 'Presence' is often used in the literature in similar ways to 'Awareness', and sometimes it is used synonymously. Schmidt describes at some length the "ambiguous and unsatisfactory" nature of the term 'Awareness' [47], however due to the general popularity of the term and lack of a substitute, we will continue to use it here. Where possible, more specific terms such as 'Location Awareness' or 'Social Titles' will be used.

interaction [44], increasing "social capital" [44], urban rendezvousing [19], maintaining a personal feeling of connectedness [38], communication grounding for other more direct interactions [38], casual collaboration [21], micro-coordination [33] and self expression [33].

Although there are many ways in which awareness information can be useful, the privacy of the individual becomes a greater concern as more of information is made available. Most of the automatic awareness systems to date have been targeted at small groups such as a work group or a close family. Where systems have tried to support the use of awareness information in broader social circles, users are required to specify the information they wish to disclose to other people by granting those people 'access' to the information. A few studies [18, 28, 16] have reported that people tend to choose to give different amounts of access to people with whom they have different relationships. However, these results are almost always reported as aggregate likelihoods (e.g. "61% of the time" or "24% of people"). From these general results it is impossible to determine whether a particular person would want to grant access at any specific moment. Being correct some percentage of the time is unacceptable as there can be a high social cost to the user if information is divulged in the wrong way.

In this thesis, we introduce a mobile awareness system called Look Who's Talking (LWT). While most awareness systems to date have been built with static or labour intensive rules that dictate what information to divulge to whom in what settings, the aim of LWT is to transcend the user's various social settings and social groups. It does this by providing semantically meaningful information, and allowing the user to grant access to that information as social situations arise. Its novel features include:

- A new type of awareness information called 'Social Titling' that aims to communicate aspects of the user's social attention. Bluetooth scans of the local environment will try to recognise other devices and match them to the user's contact list. These will then be translated into pseudonymous titles such as 'Friend' or 'MIT Lecturer' that will hopefully enable remote onlookers to make

reasonable judgements about the actual social context even though they might not normally be participants in that social setting.

- The ability to grant 'episodic access' to the device owner's context through an SMS-like message called a 'LookAtMe' (LAM). These can be sent to individuals or groups in the many circumstances where a user's day-to-day access settings do not suffice. Each LookAtMe consists of a short text message, the type of information access to be granted and the time period for which the access will persist.

- A user interface that is geared towards mobile use, including mechanisms for on-the-fly input and a glanceable summary of incoming awareness information. The interface is based on the mobile phone's address book, the means by which people are currently accustomed to managing their social information.

Subsequent to this chapter, we review some previous work in areas related to LWT. We then present an overview of the development of the LWT prototype. Following that, we look more closely at each of the two types of awareness information use in the LWT prototype (Social Titles and Geo-Location). We then detail the mechanisms for sharing awareness information. The penultimate chapter presents some reflections on the LWT system in the form of our own experiences with the prototype and a comparison to two sets of design guidelines. The thesis concludes with a summary of the specific contributions and some suggestions for future work.

Example Use Scenarios of the LWT System

Scenario 1
Eric and Fiona have agreed to meet at Quincy Markets for lunch. They are friends from school, and these days don't often see each other. Eric is running about 15 minutes late and sends a LookAtMe to Fiona with his (actual) location attached. Fiona knows she can now check on Eric's progress by glancing at a map on her cell phone. She decides to browse inside some of the shops until she sees he has nearly arrived. As Eric is chaining up his bike, Fiona glances at the map again and wanders over to meet him.

Scenario 2

Alice and Bob are co-workers whose offices are on different floors of the same building. They decide that they need to have a discussion some time during the afternoon, however Alice is about to go into a meeting with her supervisor and Bob is expecting some important visitors who could arrive at any time. In situations like this, they used to have to keep visiting each other's offices or send update emails in order to catch each other. But now, they just send each other a LookAtMe, with access to their respective Social Titles information attached. When Alice finishes talking with her supervisor she checks on Bob's situation. She sees he is done with his visitors (and is only in the company of his office mate), so she walks over to Bob's office for their chat.

Explorations in Mobile Awareness

The Active Badge system [53] provided people with a list of employees, their estimated current location in the building, and a confidence value for the estimate. The awareness information was later made available in a mobile fashion by integrating it with PARCTAB devices [54]. The AwarePhone [8] allows users to manually set 'Personal Status'. 'Activity' is deduced from the user's calendar and indoor 'Location' is "revealed by some automatic location detection system". WatchMe [35] is an 'at a glance' location and activity awareness system, built into a wristwatch form factor. WatchMe also enforces reciprocity and always lets the 'viewee' know if someone is viewing their context information. Awarenex [51] is an augmented mobile phonebook application for mutual workgroup awareness. It provides aggregated information about the status of each member's electronic communication devices, and also conveys some calendar information. Avraham et al. showed that detecting any type of 'company' may be useful in determining moments suitable for interruption [5]. Ackerman and Starr describe a system for displaying Social Activity Indicators in a desktop environment [1]. There have also been mobile systems that explore the use of Music Presence [10] (what other people are listening to), Motion Presence [11] (whether another person is moving, in this case, between cell towers), Photo-based Presence [46,17], and Mood Presence [2] (self reported by the users). The vast majority of research in mobile presence has been targeted at small, familiar groups.

Commercial Systems

Multiple Instant Messaging (IM) [6] applications exist and these are now fairly standardised in the way they permit the manual setting of presence status and the automatic communication of an away message after an activity time out. All of the most popular IM clients are now available on one or more mobile handsets. The Live Addressbook [37] (research prototype) integrated the IM 'Buddy List' concept with a

mobile phone's address book. It allowed users to manually set their Availability, Location and a brief message. This information was available to all of their buddies to see, and required constant maintenance. There are also a number of commercial 'people locators' such as the GPS based Boost Loopt [34] and Helio Buddy Beacon [13], and the SMS based Google Dodgeball [20]. SMS itself is also often used by mobile phone owners as an asynchronous peer-to-peer location reporting mechanism [33].

Social Scanning

ContextContacts [40] is perhaps the piece of previous work that is closest to Look Who's Talking. It uses Bluetooth scanning to detect familiar people, cell tower tracking to detect locations, and also conveys the current mobile phone ring setting (e.g. mute, but vibrate). The visibility of Presence information to members of various groups of contacts can be set on/off manually. Although the creators of ContextContacts were specifically aiming to design a system for a more general audience than a work group, they suggest that their system is best suited to use between long-term relationship groups such as what Lickel et al. [44] refer to as intimacy groups and task oriented groups. MobiTip [45] uses Bluetooth scan data as Social Positioning information. The mobile agent presents a set of 'tips' based on recognised social setting. Nearby Bluetooth devices are also shown to the user in an 'orbital' graphic representation. The AwareMedia system [9] consists of large displays situated in the public areas of a hospital. Hospital staff are tracked within the building and anyone who glances at the screen can see who is with whom, in the various rooms of the hospital. Temporal awareness is also provided through a visualisation of recent activity. Bustle [52] is a system that 'hitchhikes' on WiFi enabled devices. It sends environmental scans and location data anonymously to a central server, where it is aggregated and used to make judgements about the busyness of a location (such as a coffee shop).

Managing Access to Awareness Information

Lederer et. al. [32] developed a prototype called Faces in order to investigate the potential pitfalls one might encounter when designing systems that disclose real-time personal

information. Their system gave the user the ability to specify a set of disclosure preferences and encapsulate them in a 'Face'. Then, in different situations, the user can put on the most suitable 'Face'. The five pitfalls they identified are included in the 'Evaluation' chapter of this thesis (Chapter 7). Hong and Landay [26], describe the Lemming Location-Enhanced Instant Messenger system, built on their (privacy conscious) Confab Architecture. It allows users to respond to access requests from other users by saying 'just this once' or with criteria such as times of day. The Reno social location disclosure service [49, 27] is a J2ME 'location messaging' application that runs on Nokia's Series 60 phones. It uses cell tower IDs to recognise user-recorded places. Users are given the access management options of automatic disclosure, manual location 'push', and explicit "Where are you?" requests. Their 'automatic disclosure' option is not 'ambient awareness information' as such because it is only triggered upon entry or exit from a pre-defined and agreed upon location. Will You Help Me [14] dealt with the issue of privacy by only divulging information when something abnormal and potentially safety threatening occurred. A number of systems include the ability to convey just-in-time awareness information. These include, for example, Quiet Calls [39], Negotiator [57], and Autonomous Interactive Intermediaries [36]. For a more extensive discussion and comparison of UbiComp access and privacy techniques, see Price et al. [43].

Chapter 3:
The Look Who's Talking Prototype System

The Look Who's Talking system is designed to operate on a personal mobile device and provides a new form of low-level, always on, interpersonal communication. LWT detects the people who are in the company of the mobile device owner (via Bluetooth scanning) and matches these people to predefined Social Titles. It also uses GPS to sense the device owner's location. It then communicates this Social Title and location information over the cellular network to the phonebook contacts who have been given permission to access it. Permission can be granted either by a broad and ongoing 'Category Rule' associated with a group of contacts, or when the user sends a specific person a 'LookAtMe' message with an attachment of some time-limited access to their awareness information..

This chapter presents an overview of the LWT prototype which has been developed as a concept demonstrator. The chapter includes an overview of the navigational structure, the top-level screens, and various aspect of the system architecture. Social Titles, location awareness, and the Category/LookAtMe mechanism of access management are explored, in detail, through Chapters 4, 5 and 6 respectively.

The LWT prototype runs on top of J2ME on the Motorola i870 iDEN handset (Figure 1 (a)). Awareness information is communicated over the iDEN Internet Protocol (IP) data network in a peer-to-peer fashion. There is therefore no server component to the system. The J2ME platform is designed to operate on many different mobile platforms and provides a basic set of application building blocks. An application is compiled into a 'MIDlet' and downloaded onto the device using SDK tools provided by Motorola. Look Who's Talking, like many J2ME applications, make extensive use of the UI building blocks called Lists and Forms. LWT also often makes use of J2ME 'Commands' for collecting input. In the case of the i870, commands are accessed by using either the two 'hot buttons' beneath the bottom left and right corners of the display or (if there are more than two) by pressing a separate 'menu' button.

The prototype system's primary interaction metaphor is an 'augmented phonebook'. The phonebook is the tool that people are used to using for on-the-go naming, categorising, finding, and communicating with other people. A phone is also a device many people carry with them.

Figure 1

(a) The Motorola i870 Mobile Handset   (b) The 'Presence List' View of Contacts.

The main element of the user interface is the list of contacts, called the 'Presence List', as seen in Figure 1 (b). The user is able to switch between the Presence List and the Main Menu using a toggle-like command. The complete list of commands available from the Main Menu is presented in Table 1. From these two 'launch screens', a handful of auxiliary screens allow the user to view, create, and manage the peer-to-peer information communicated and collected by their device. The set of possible 'navigation paths' through the various screens in the user interface is shown in Figure 2.

Table 1

Main Menu Options

Presence List	Access the main view of contacts in your phonebook
Send LookAtMe	Create a new LAM to send
LookAtMe InBox	Lists recently received LAMs
LookAtMe OutBox	Lists recently created LAMs
Contact Categories	Create/Manage Categories
My Status	Shows how the user looks to others
Mute/Un-Mute	Stops (or resumes) all 'automatic' messeges
Quit	Exits the Java MIDlet

The phonebook-like contact-list paradigm is useful because each user of LWT needs to maintain their individual set of category-based and person-to-person access settings. This is in direct contrast to many of the systems mentioned in the related work section (above). Those systems require the user to join a closed clique-group, in which any new user is automatically and mutually connected to every other member of the group. The categorisation of contacts is also a feature included on many contemporary mobile phones (e.g. to manage ringtones), and likely to be familiar to users. LWT uses categories to help associate Social Titles with contacts and also to manage access permissions.

LWT System Use

The LWT system provides users with a summary of incoming awareness information, prioritised according to the information currently being received and sent between the user and their respective contacts. This list is intended to show the user the most pertinent information with respect to the current moment in just a quick glance. If further information is required, the user can choose to see the more detailed 'Contact Status' screen for the respective contact.
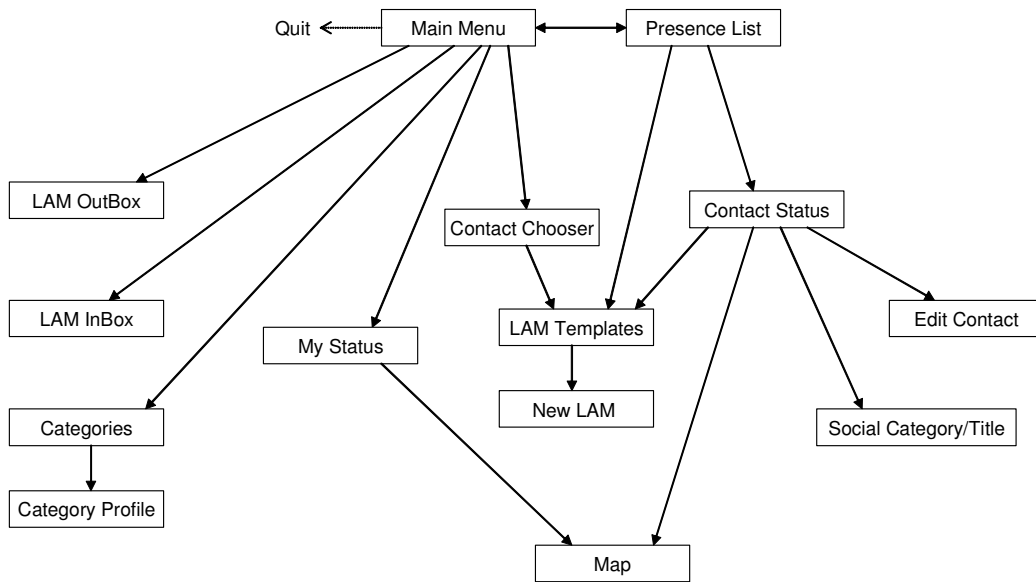
Figure 2

Possible Navigation Paths of the Look Who's Talking User Interface

The Presence List shows, for each contact, whether that contact is physically near some number of people they know. It also acts as an indication of whether the respective contact is currently sending social or location information. If the remote contact is not transmitting, the respective icons are greyed. Figure 3 shows an example in which Jaewoo Chung is sending both social information (the colored people-like icons) and location information (the black globe), and Chou-Chi Silver is sending just social Information. The numbers next to the icons relate to the quantity of nearby devices that have recently been detected.

The summary list is ranked in such a way as to place the 'active' contacts at the top of the list. An 'active' contact is one who is currently or recently sending the user contact information, or who has a LookAtMe currently active (in either direction).
This is done to increase the chance that the people the user might be more interested in finding out about are shown on the main screen. A contact list can easily contain

hundreds of contacts and we have aimed to assist 'glancibility' and 'ambientness' rather than have the user actively seek out specific contacts.

A user can implicitly 'pin' a contact to the top of the list by sending them a LookAtMe. This allows the user to keep an eye on a specific contact and, at the same time, the respective contact will implicitly know that their information is more likely be seen by the user. The rest of the contacts are listed in the same order as the user's normal contact list.

Figure 3

The Presence List with incoming presence information from two contacts

System Architecture of the LWT Prototype

This section introduces the software framework on which the LWT prototype is built, then outlines the main software modules, and finally considers how some of the constraints of developing on a mobile device have been dealt with.

The Contella Framework
The Contella Framework is a J2ME code base that has been in development within the MIT Media Lab's Speech and Mobility Group over the past two years [14]. Originally designed as part of a different phonebook-based Master's project, the framework has been modularised for use in LWT and other applications. A number of the software tools

contained in the current Contella Framework were constructed as by-products of the LWT development process. By basing LWT in this framework, we hope that it will be easier to integrate the functions of LWT with other applications developed within the group. Additionally, the use of wrappers around common system services aids portability to other devices with slightly different J2ME implementations.

The LWT system's Contact Database is also somewhat based on the Contella Contact Database. One benefit of this is that LWT will be compatible with a mechanism for adding contacts by Bluetooth that already exists in another Speech Group application and is likely to be added to the Contella Framework in the coming months.

Software Modules

The main software modules of the LWT system are shown in Figure 4. This is a simplified view of the architecture and does not represent all the classes. This section gives an overview, while some specific modules and their helper classes are described in later chapters. There is also a main class called 'MainMIDlet' that is initially executed and creates the other classes.

There are three Manager classes that act as the primary 'workhorses' of the system. The Presence Manager looks after all activity to do with Social Presence information and uses the Contella 'BlueTooth Provider' wrapper when it performs social scanning. The Location Manager looks after the marshalling of absolute location data and uses the Contella 'GPS Provider' wrapper to obtain GPS information. Both the Presence Manager and the Location Manager run their own data collection threads, and this is indicated on the diagram by the ↻ symbol. The LAM (LookAtMe) Manager is responsible for sending LAMs generated by the user, and receiving incoming LAMs. All three managers make use of the Contella UDP Network Tools to send and listen for messages. Sitting below the Contella modules is the Motorola J2ME API, which forms the base of the system.

The main data structure employed by the LWT system is the Contact Database (ContactDB). It maintains the set of Contacts and Contact Categories. Each Contact is associated with one Contact Category. Each Contact is also associated with a set of

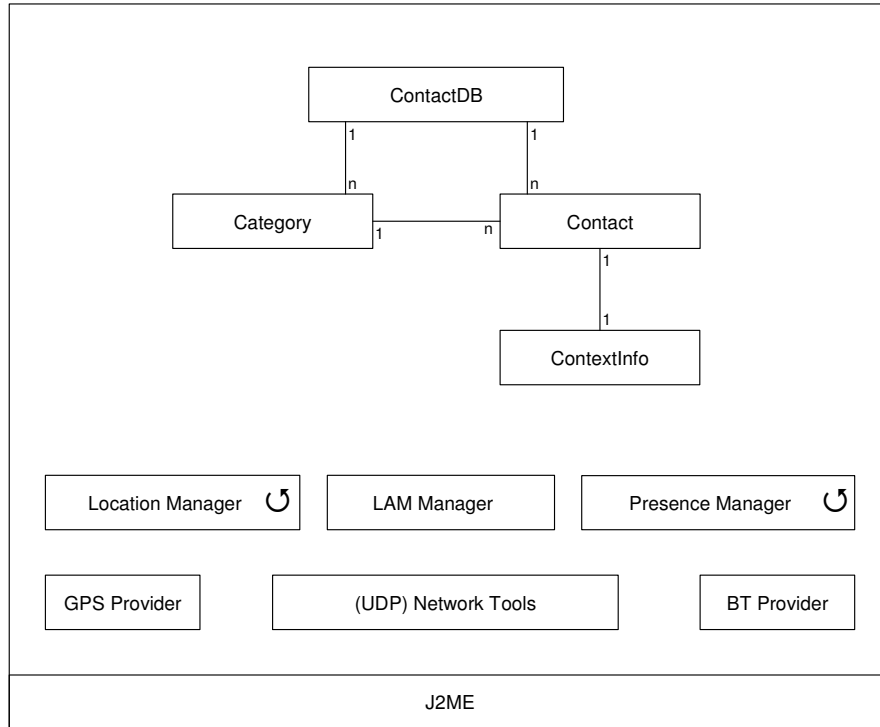Context Info that is used to store the latest context information received from the respective contact.

Figure 4

Primary software modules of the Look Who's Talking prototype

In addition to these primary modules, the development of LWT has introduced new software tools to the Contella Framework for thread debugging/monitoring, network pinging/probing, network message debugging/monitoring, Bluetooth scan monitoring, and the rendering of maps from a third party web-based provider.

Developing Software for the Mobile Device

A primary concern when developing software for a mobile device such as the i870 is power consumption. This influences software architecture decisions at almost every level. Power consumption is increased by initiating additional threads, Bluetooth scanning, using AGPS, and the sending/receiving of messages over the network. Many of the

design choices, including the rates of various activity loops, have been aimed at enabling the system to run continuously for more than fifteen hours (on standby[2]).

Much of the LWT user interface and some of the data structures rely on lazy evaluation rather than an event model updating everything whenever states change. This is based on the assumption that user interaction will happen far less frequently than, say, an incoming social awareness message. User interactions will probably only occur a few times per day, while messages containing awareness information could easily arrive every few seconds.

There are very few threads used in LWT and those that do exist are set to run as slowly as possible. The Presence List uses a thread to update its contents every 20 seconds. In order to update, the Presence List renders new images based on the status of each Contact – an expensive process. It would be a totally impractical power drain to be rendering these images and re-sorting the Presence List whenever a new snippet of awareness information is received. The Presence List thread also saves power by first checking if the screen is actually visible to the user before performing an update.

Network Communication (UDP)
The LWT system uses peer-to-peer UDP[3] over Nextel's iDEN data network as the primary means of communication. The iDEN network provides each phone with its own static IP address. Some of these are private IP addresses (of the form 10.*.*.*), but all phones on the network can see and communicate with each other directly.

By having a peer-to-peer topology, LWT does not require the existence of, and access to, a central server in order to operate. This means that LWT does not have a single point of possible failure. It also means that individuals can be more confident that their private information is not being stored anywhere that they are not aware of. As far as the user is

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[2] The LWT system is considered to be in standby mode if the screen is off, but context scanning is active and messages containing awareness information are being sent and received.
[3] The User Datagram Protocol (UDP) is one of the main protocols of the Internet Protocol suite. It does not guarantee delivery like it's sibling Transmission Control Protocol (TCP). It is, however, faster and more efficient.

concerned, if a piece of awareness information is not able to reach its intended destination, it will simply cease to exist.

All UDP messages sent and received by LWT take a similar form. They begin with a header, that may include periods ('.'), and then contain a number of text string fields delimited by colons (':'). In this document, we describe messages using the format:

LWT.MESSAGE.HEAD:{field_1}:{field_2}:{field_3}

Where "**LWT.MESSAGE.HEAD**" is the message header telling LWT which software module should receive the message, and the subsequent "{field_n}" strings are parsed out by that module as parameters.

One convention used in LWT is to include the sender's local IP address in the 'field_1' slot to indicate the originator of the message. Of course this could be easily spoofed by a third party, however this is not a huge worry for the prototype as a production system would most likely include some sort of encryption of these massages.

Chapter 4:
Social Titles as Awareness Information

The primary types of awareness information collected by LWT are social context and geospatial location. Between them, these two enable (to some degree) many of the beneficial aspects of awareness information mentioned in the introductory chapter. This chapter focuses on social context.

Social context information is collected by Bluetooth-scanning of the area proximate to the phone owner for other Bluetooth devices. Some of these devices will be recognised and matched against contacts in the contacts list. Bentley et al. call this type of awareness-information-from-environmental-sensing 'Perceptive Presence' [12].

Instead of communicating just the number of known devices, or the actual names of the recognised contacts, LWT will primarily convey Social Titles that the user has assigned. Examples of possible Social Titles are 'co-worker', 'boss', 'school teacher', 'family member' and 'soccer team member'. It is expected that these titles will not change very often. This assertion is based on Fiske and Taylor's discussion on the temporal aspects of the organisation of social information in our memory [23] and also on the results of two informal web based survey conducted at the Media Lab.

A project hypothesis is that translating the sensed social context information into this more semantically meaningful form will enable remote onlookers to make reasonable judgements about the actual social context even though they might not be normal participants in that social setting. At the same time, it is expected that people will find Socially Titled information to be more useful than simple proximity numbers and less invading of privacy than sending the actual names of their present company.

This chapter describes two surveys that were conducted to help inform the design of the system. Both surveys were conducted via a web based survey system. All the information collected in these surveys was anonymous and was provided only by people who took the

survey of their own accord (in response to an email advertisement). Following the description of the two surveys is a description of the use and implementation of the LWT prototype system. The chapter concludes with some observations of the use of Bluetooth technology in the context of LWT.

Survey 1: Initial Exploration of Social Titles

The initial survey was designed to explore the nature of the social titles people use to describe each other and also the categories into which we might put people. A cross-section of age, gender and to some extent geography was contained in the list of more than 30 people who were sent the advertisement for the survey. 12 complete responses were received.

Respondents were asked to write down (on a private piece of paper) the names of six people they knew. They were encouraged to choose people from their various social groups.

The **first survey question** asked how the respondent would describe each of their six chosen people to the remaining five people on their list; a total of 30 (directional) descriptions. They were prompted to think about how they would complete the sentence "I was chatting with…" (and some examples were also given). Respondents were also told they could write "actual name" if that was what they would normally use.

The 'actual name' option (or a real name) was used for 30% of the responses. Of the remaining responses "friend" was the most common description. Specific relationships were almost always used for family members (e.g. "Aunt", "Dad", or "Sister"). Other recurring responses included "housemate"/"roommate", "colleague"/"workmate" and "supervisor"/"boss". Some descriptions apparently provided inherent context information (e.g. "hairdresser" or "doctor").

For each social description, the first survey question also asked for an indication of whether the description was likely to change within a timeframe of six months, one year,

five years, or never. The aggregated responses are shown in Table 2 and give some reasonable confidence that changes to individual social titles are likely to be quite infrequent. This in turn means that, while LWT should provide a function to edit Social Titles, it is not something that needs primary real estate on the main screen nor does it need to be one of the most easily accessible functions while 'on the go'.

Table 2

Likelihood of change in Social Titles

Time Frame	Positive Survey Responses
Six Months	5%
One Year	13%
Five Years	13%
Never	68%

The **second question** in the survey asked (of each of the 30 descriptions) whether or not the actual name of the person being described was known to the respective listener. Of the 360 relationships collected, 45% knew each other's actual name.

In the cases where the actual name was known, people would use the actual name only 60% of the time, with the remainder almost evenly split between describing specific family members and non-family members. In other words, even when someone's name is known, it is by no means uncommon for a Social Title to be used instead. In the cases where the actual name was not known, respondents were more than 90% likely to use the same (or nearly the same) Social Title to describe a specific person regardless of the description recipient.

The **final question** of the survey asked the respondent to enter any/all of their social groups that each of their six people belongs to. It is reasonably clear from the responses that there are many instances in which there is a strong link between the Social Titles and social groups reported for a given person (e.g. "Friends"/"Friend" and "Work"/"Colleague"). However there are also many exceptions too. For example a "Boss" or "Supervisor" is usually an exceptional member of the "Work" group, and a

"Housemate" or "Roommate" is usually an exceptional member of the "Friends" group. Also, as alluded to above, the "Family" group seems to almost always contain exceptions.

Respondents chose, on average, to provide multiple group memberships for 25% of their selected people. The vast majority of these seemed to be an attempt to define the subtleties in scope of a 'work' or 'friend' relationship (e.g. "research group & friend" or "university friend & climbing friend").

Survey 2: Simulated Use of the Proposed LWT System.

A second survey was conducted to investigate the creation, use and interpretation of Social Titles in a manner similar to the operation of the LWT system. This was also a web based survey and did not directly use or refer to the LWT prototype. The investigation was conducted this way because an actual trial of the prototype system would have required the saturation of someone's daily social encounters with mobile devices running LWT and this was not possible within the scope of the project. The survey advertisement was sent to more than 60 people and 22 (anonymous) respondents completed the entire survey.

The **preamble question** was designed to both explain the main features of the proposed system (as reference for the remainder of the survey) and also to gauge if there was a predisposition towards the LWT concept. The survey asked the respondent to rate their likely willingness to include such a feature in a device that they carry using a scale of "Never ever" (=1) to "I want it right now" (=5). The collected results of this question are shown in Figure 5 and the average of all responses was 3.19 (somewhere between "Maybe" and "Sure, why not?").
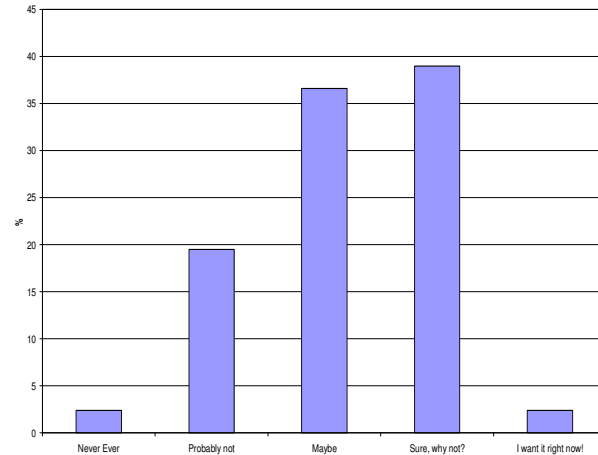
Figure 5

Likelihood of survey respondents to include LWT-like feature in their mobile device

The remainder of the survey was split into two parts. The first looked at the creation of awareness information and the second looked at the reception and interpretation of similar information. These are detailed below.

Generation of Social Titles

The first section of Survey 2 invited respondents to first pick three different examples of regular social situations in their daily life. For each of these three situations the survey then asked four questions.

The **first question** of the section asked respondents to enter up to six 'labels' (i.e. Social Titles) that would give the "greatest meaning/utility to any remote person who might be receiving the information". As can be seen in Figure 6, more than half of the situations considered by the respondents included three or more companions and more than one fifth included six or more companions. The types of labels used were not obviously different from the descriptions collected in Survey 1. Of note, however, was a tendency by some people to imply 'type of work' (e.g. volunteer worker vs. study mate vs. professional staff member) in the labels of some companions.
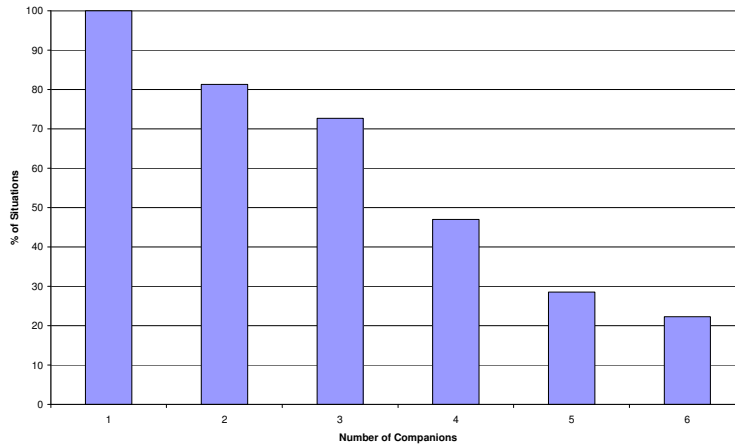
Figure 6

Proportion of social situations containing various numbers of companions

The **second question** asked "How useful do you think this description would be if it were available to anyone/everyone in your phonebook (at your discretion)?" on a scale of 1 (Not at all) to 5 (Immensely). The overall average of responses to this question was 3.08 (equating roughly to the "Somewhat" label on the scale). The respondents seemed to give higher ratings on this question whenever the Social Titles they used were for specific people e.g. "Sister" or "Boss" and also whenever they had indicated a greater number of companions were present. However, due to the way the data has been collected, we cannot numerically separate these two possible trends.

The **third question** asked respondents to indicate the groups/categories of people in their phonebook that they would allow to see this sort of Social Title information on a regular basis. The vast majority of responses included "Everyone", "Family" and/or "Friends". Running a distant fourth was "Co-workers". There was also the occasional qualification to these groups such as "close friends" and "uni colleagues".

The **fourth and final question** asked about the times of the day/week that respondents would be comfortable divulging their Social Title context information to each of the groups in the previous question. The majority of people said "any time", "all the time" or

"whenever". Other responses included "evenings", "weekends" and/or "business hours". Also, two people reported specific times ("8am-8pm" and ">6pm and weekends").

Reception of Social Titles

The second section of Survey 2 asked (the same) four questions about each of five different possible situations (a total of 20 questions). The situations were drawn from responses to the initial survey, and are shown in Table 3. The survey asked the respondent to choose four people from different aspects of their daily life and answer all of the twenty questions with respect to each of those four people.

Table 3

Social Situations considered in Part 2 of Survey 2

	"You glance at your mobile phone and it tells you that the respective person is currently close to:"
Situation #1	"Boss" "Co-worker"
Situation #2	"Acquaintance 1" "Acquaintance 2" "Acquaintance 3"
Situation #3	"Mum" (or "Mom") "Dad"
Situation #4	[No one they know]
Situation #5	"School Friend"

The **first question** asked by this part of the survey regarded the possible deductions that could be made about a given person's current context.

For Situation #1, many people said they thought the person was "at work" and "busy"[4]. About one quarter of respondents were quite detailed in their comparisons between the

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[4] "busy" was actually an example prompted in the survey question.

people they chose to consider. For example "Has just got new job, would like to gossip at earliest opportunity." vs. "Busy, in a meeting, at ... labs on level 4 or 5. Probably free within half an hour."

For Situation #2, many respondents assumed that the person was "out socialising". Most noted a high degree of ambiguity, saying (for example) "could be anything". However, some respondents gave suggestions within a specific context (e.g. "I'd probably figure [person] D is at school, where they have lots of acquaintances. Otherwise, [person] D is rarely around people they don't know").

For Situation #3, respondents often assumed that the location of the respective person was the parents' house or that they were at home with parents visiting. The responses tended to be quite detailed and tended to vary across the four chosen people.

The responses for Situation #4 showed the least variation of all the situations, however some respondents did make guesses about the respective person's context such as "at home", "in public" or "commuting". Most responses were vague and clearly apprehensive guesses. People tended to assign their "guess" to all of the four of the people they chose to consider.

The responses for Situation #5 were split between those people who currently attend school and those who do not. Of those no longer attending school, some respondents assumed the person was in an everyday social encounter with a close friend, while other respondents inferred that it was a rare or chance meeting.

The **second question** in this part of the survey asked if there were specific times of the day or week in which the survey respondent would expect to see each of their selected people in the situations presented in Table 3.

Most respondents seemed to know, and report on, when their chosen people worked (#1). When asked about collocation with three acquaintances (#2), most respondents said

'Anytime'. Some made judgements about whether the situation was likely to be during the day (e.g. "9am - 5pm") or "evening, weekend". A meeting with Mum and Dad (#3) seemed most likely on "Weekends". Being in the company of no known associates (#4) was most frequently expected to happen on weekends or at night. Some respondents assigned probabilities to the likelihood of the situation (e.g. "very rarely" or "not very often, almost never"). This situation (#4) also seemed to be somewhat polarising in that respondents made reasonably specific judgements on whether a person was likely to be at work or not (e.g. "during commute times[,] lunch, or night"). The company of a school friend (#5) was very frequently "eve/weekend" or "outside work hours", and also "any time".

The **third question** asked respondents to rate "the extent to which being able to see this information might affect your actions". This was done on a scale of 'Not at all' (=1) to 'Definitely' (=5). The sorted and averaged results of this question are shown in Table 4. There is a distinct gap between the two more specific sets of Social Titles (Mum/Dad and Boss/Co-worker) and the remaining more general ones. This is consistent with an intuition that more specific information is likely to be more useful.

Table 4

Responses to the Survey Question: "Please rate the extent to which being able to see this information might affect your actions" (on a 1-5 scale)

Social Company	Average
Mum/Dad	2.98
Boss/Co-worker	2.96
3 Acquaintances	2.76
No one	2.73
School Friend	2.70
Overall average	2.83

The **fourth and final question** was a free-form text field that asked respondents "How/Why" the information provided in each situation might affect their actions. When seeing someone else was with "Boss/Co-worker" (#1), some people said they would decide not to call and to SMS instead. One respondent noted that the co-presence of three Acquaintances (#2) showed "that they're not asleep and could be phoned if something is urgent" and another said that "acquaintances don't hold as much weight as boss/coworker so interrupting might be possible". Nearly all of the responses to the co-presence of Mum/Dad (#3) reflected in some way on the work/social nature of the relationship the respondent had with the person (e.g. "would not interrupt work colleagues or friends when they are in private with parents" and "unless I know they don't particularly like their parents, I won't bother them when they are with family"). If the person was with no one they knew (#4), most respondents said that they thought an interruption would be okay. If the awareness information conveys that a person is in the company of a school friend (#5) there seemed to be two options for action (e.g. "Depending on what context I know them from, knowing they're in a social situation compels me to either join in or give them space"). Also, one respondent made a point of linking their actions to their prior knowledge of narratives used by the person: "depends on their opinions of their school friends".

Discussion of Survey Results

The two surveys were not intended to try and determine whether Social Titles are the 'most accurate' or 'best' way of characterising a social situation. Instead, they were constructed to help inform the design of the LWT system. It was also hoped that the respondents' answers would give some indication of whether this alternative type of social context information can achieve a reasonable threshold of utility. The results seem to indicate that this is the case.

People were willing to make specific deductions that combine (Social Title) awareness information with prior knowledge about the respective individual. The specificity and variety of the deductions is greater when the awareness information being provided is targeted at specific people or a specific class of people.

Respondents, on average, reported that they would be somewhat willing to carry a device that included the Social Titles feature and that it was, in a variety of situations, likely to help them decide what course of action to take.

Use of Social Titles in the LWT Prototype

Each Contact in the user's phonebook can either inherit a default Social Title from the Category of which it has been made a member or the user can assign a specific title to a specific contact. In order to assign a default category title, the user selects the appropriate category from the category list and enters the text in the 'Default Title' field as shown in Figure 7 (a) and (b).

Figure 7

(a) List of categories   **(b) Category Profile**   **(c) Access Rule Options**

A user may wish to override the default in order to assign an 'exceptional' Social Title, such as a singular "Boss" within a category called "Work". Figure 8 (b) shows an example in which the user has chosen to use the title "Office Mate" instead of using the default title "Speech Group Member" (as in Figure 8 (a)). Here, the user is also be able to see the Social Title assigned to them by the respective contact (in other words, user A can see how contact B has titled user A). This information is made available to the user for

primarily two reasons. One is social lubricant - the opposite of saying something behind someone else's back. The other reason is that, as Sen et al. [48] report, public disclosure of individually created labels can promote the evolution of a common taxonomy vocabulary.
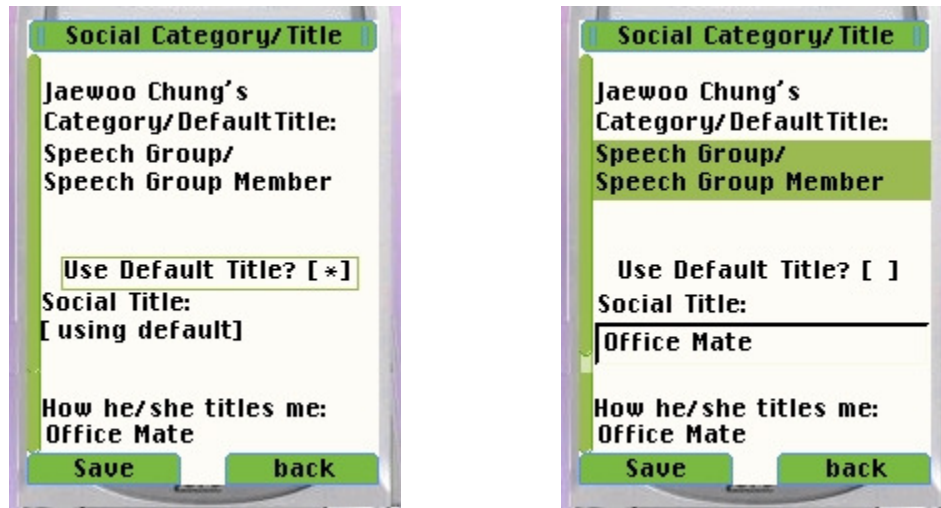

Figure 8

Setting the Social Category/Title for a Contact
(a) Using the Default Title of the Category   (b) Overriding the Default

The Presence List (shown earlier in Figure 1 and Figure 3), in addition to being the primary way a user views and accesses contacts, provides a summary of the most actively transmitting users. If the user switches to the detailed view of a specific contact, the entry from the Presence List is repeated at the top of the detailed Current Status screen (see Figure 9). If the respective contact is currently transmitting social context information, this bundle of icons includes three coloured people, each with a number next to them. The green icon indicates the number of nearby companions known to the contact. The yellow icon indicates the number of nearby companions (actually Bluetooth devices, as described below) who are not known to the contact. The blue icon indicates the number of previously unseen devices detected in the latest scan (i.e. the companion 'flux').
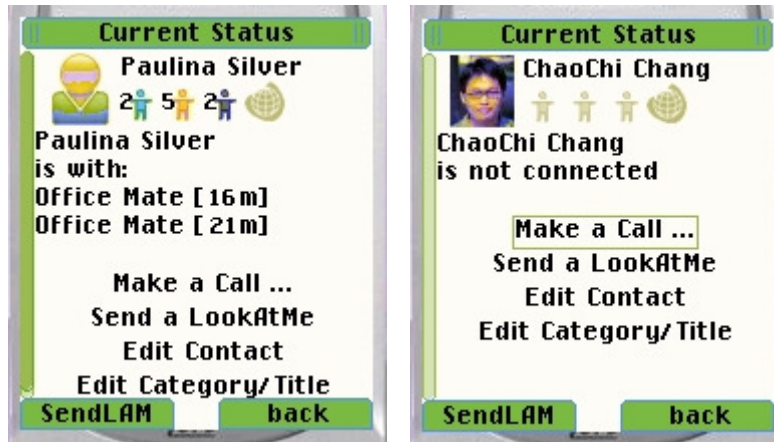
Figure 9

(a) The detailed information screen for a contact who is sending social context info
(b) The detailed information screen for a contact who is not

On the Current Status screen is the list of the Social Titles belonging to the known companions. Next to each of these companions is an indication of how long they have each been in that person's company. As the LWT system is based on the phonebook metaphor, this screen also includes options to place a call, send a message, or edit the contact information.

Similar to the Current Status screen for each contact, LWT provides a "My Status" screen. This is identical in format, however it does not provide options such as "Make a Call…". It allows the user to quickly see how they are being presented to whomever their device is currently sending awareness messages.

Implementation of Social Titles

The detection of local companions is achieved through Bluetooth scanning. The system therefore assumes that the devices it wishes to recognise are set to 'discoverable'. For this reason, LWT constantly checks to make sure the device it is running on is set to 'discoverable'.

A full BT scan on the i870 handsets takes between 10 and 35 seconds. During the development of LWT, a full scan was set to trigger every 60 seconds. This was found to drain the phone's battery too quickly. Later, once the prototype was more complete, a sampling period of 5 minutes was used. This enabled the software to run (with other services such as GPS) for more than 15 hours without totally depleting the battery. There is a trade off here with battery and processor life on one side, and awareness information accuracy and latency concerns on the other. A period of 5 minutes is probably a little too long for social interactions. While long term trials with a specific handset would be needed to know for sure, we estimate that a scanning rate of 2 to 3 minutes might be a reasonable compromise.

After each scan takes place, the results are placed in a short buffer. This collection of recent scans enables the LWT system to consider the number of new devices detected in the latest scan (to depict as 'flux' next to the blue person icon mentioned above). It also provides some additional robustness to the scans by 'forgiving' a missed scan. In other words, if a companion is seen for some number of scans, then is not seen in some small number of immediately subsequent scans, they are still deemed to be present. For a BT scan period of 60 seconds, the LWT system was set to 'forgive' two scans. When the scan rate was set to 5mins, the system was set to only 'forgive' one scan. It is worth noting that even this one scan buffer creates a latency of between 5 and 10 minutes – again, probably too long for normal use.

Each time a new list of 'Local Companions' has been determined, the Presence Manager sets to work transmitting this information to those who currently have access. The flow of information is depicted in Figure 10.

The Presence Manager assembles a UDP message of the form:

    LWT.COMPANION.TITLE:{local_IP}:{social_title}:

    {sequence_number}:{together_seconds}

The sequence_number field is used so to distinguish between two companions that could have the same Social Title assigned to them. The together_seconds field is used to

convey the amount of time (in seconds) since the companion was first detected. We use relative time (and assume sub-second network latency) as this removes any clock synchronisation issues between devices. The Presence Manager sends the message to all of the contacts in the phonebook who currently have access to the user's social context information.
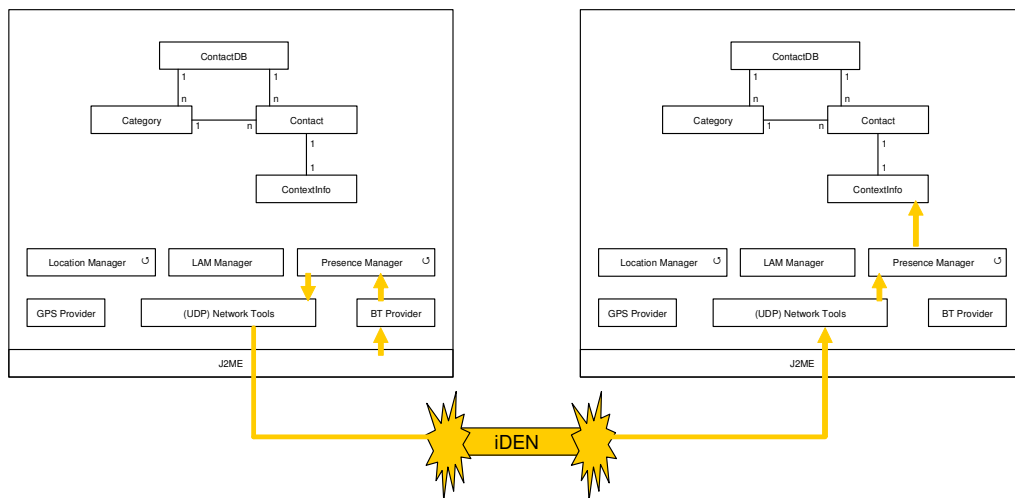

Figure 10

Module Diagram showing the path of social context messages between two systems.

Upon reception of an **LWT.COMPANION.TITLE** message from another contact, the Presence Manager parses out the respective fields and stores the information in a new 'Remote Companion' class. This data structure class is added to a Vector maintained by the respective Contact's ContextInfo class.

There are two ways in which a Remote Companion class can be deemed no longer valid and subsequently removed from the ContextInfo class's Vector. The first is the reception of a **LWT.COMPANION.GONE** message. This takes a form very similar to the **LWT.COMPANION.TITLE** message and is sent whenever a companion is deemed to be no longer present by the sending Presence Manager. The second cause for a Remote Companion class to be removed from the ContextInfo class's Vector is when a timeout is exceeded. This timeout only exists as a backup in case a **LWT.COMPANION.GONE**

message is not received. In the LWT prototype this timeout was set at 10 minutes (twice the period of a Bluetooth scan for local companions).

Issues with the Bluetooth Implementation

The i870 phone performs its Bluetooth scan in two stages. The first is a rapid scan to collect as many MAC[5] addresses as possible. This takes about 10 seconds. It then revisits each of the detected devices to request their Friendly Names. Friendly Names are human readable strings entered by the device owner or manufacturer. In our experience, a full (two step) scan can take 15 to 35 seconds.

For the social scanning in LWT we only require MAC addresses and not the Friendly Names. We expect that Bluetooth scanning could be improved, and power usage decreased, if the java interface allowed for scanning of only MAC addresses. The J2ME library currently provided by Motorola does not allow us to choose only the MAC address scanning.

During our trial usage of the system we have experienced a near perfect degree of scanning accuracy over periods of several hours. However, this has only been possible outside our lab environment. Inside the Media Lab, there are tens or hundreds of BT devices, and in some areas of the building more than 50 might be simultaneously visible. The i870 seems to be capable of detecting a maximum of 20 surrounding devices at a time and therefore often misses the ones running other instances of LWT. This also results in an artificially high 'flux' reading.

Two factors could be contributing to this issue. Firstly, the i870 seems to have a strict time limit (of about 10 seconds) in which it conducts its scans regardless of whether there are additional devices. Secondly, there might be interference within the 2.4MHz range that Bluetooth uses. Specifically, it is the same frequency band that is used by 802.11b WiFi and this is ubiquitous in the Media Lab. Both of these factors could easily be present in everyday contexts such a lecture hall or a conference.

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[5] The Media Access Control (MAC) address is a quasi-unique identifier attached to a computer's network interface adaptor. It acts like name for the computer within any network to which it is attached.

Chapter 5:
Geo-Location as Awareness Information

The second type of awareness information used within the LWT prototype is geo-location. As alluded to in the introduction, this type of information can be useful for (among other things) urban rendezvousing and micro-coordination. It is a type of information that people are often more protective of and it is probably less likely to be divulged to as many people as the Social Title information discussed in the previous chapter. It is not a new type of awareness information, but it has not often been included in research prototypes that are not restricted to a small group of people. We have included it in the LWT prototype as we believe it helps to illustrate the benefits that may come from using the episodic access technique described in the next chapter.

The Motorola i870 provides location information via an Assisted Global Positioning System (AGPS). AGPS leverages the mobile device's ability to communicate with cell towers. The iDEN cell towers know their own location and can help the phone solve the positioning equations. This results in a faster first-fix (usually within 30 seconds) than with conventional GPS receivers (often 3 to 5 minutes).

The Location Manager drives the process by prompting a scan every 60 seconds (see Figure 11). If the GPS provider is able to return a current location, the Location Manager builds a UDP message of the form:

LWT.GPS_UPDATE:{local IP}:{latitude}:{longitude}

The Location Manager then sends the message to all of the contacts in the phonebook who currently have access to the user's location information.

Upon reception of an **LWT.GPS_UPDATE** message, the Location Manager parses out the latitude and longitude information and stores it in the respective Contact's ContextInfo class.
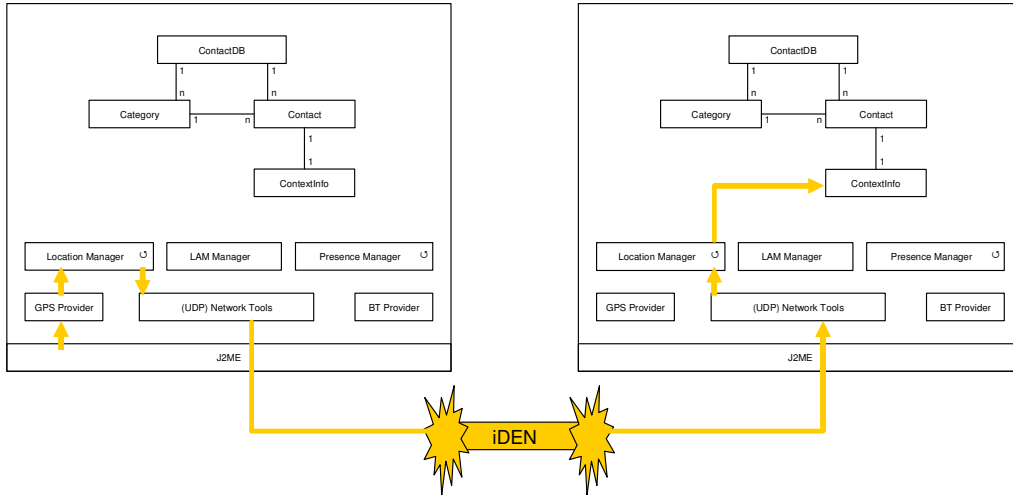
Figure 11

Module Diagram showing the path of location messages between two LWT systems

Whenever there is current location information available from a phonebook contact, the Presence List will blacken the respective globe icon (Figure 12 (a)). Similarly, the Contact Status screen will blacken the globe icon, and it will also provide an additional "See Map…" user option (Figure 12 (b)). If there has been no GPS update from the respective contact within the last 5 minutes, they are assumed to be no longer transmitting location information, and the globe icon in both screens will revert to grey.

Figure 12

(a) Presence List showing a blackened globe icon (left)

(b) Contact Status Screen with "See Map…" option (right)

When the user chooses the "See Map…" option, the phone issues an HTTP request to a web based map service. The full screen map takes about 8 to 10 seconds to download over the iDEN network, and is shown on a J2ME 'Canvas'. Figure 13 shows the location of this Map-Canvas in the LWT Navigation Graph. By default, the map has a field of view of approximately one kilometre, as can be seen in Figure 14 (a). The phone keypad can then be used to select zoom levels with the buttons 1-9 and map modes of Normal, Satellite or Hybrid can be selected with the buttons '*', '#' and '0' respectively. Examples are shown in Figure 14 (b) and Figure 14 (c). LWT also includes the user's own location information (on a similar map) in the 'My Status' screen.
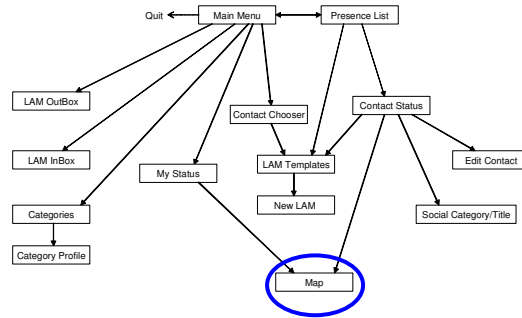
Figure 13

Location of the Map Canvas in the LWT Navigation Graph
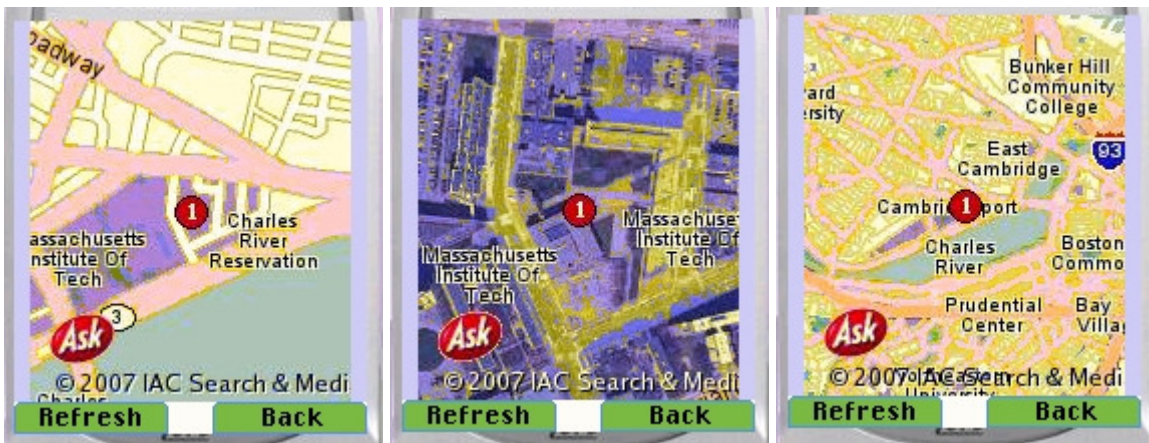
Figure 14

(a) A (default) map view   (b) Zoomed in, and in 'hybrid mode'   (c) Zoomed out

The requests for map images represent the one instance in LWT where a third party is sent some awareness information. This somewhat contradicts the privacy motivations for creating a peer-to-peer system. Ideally, for a deployable system, the maps would already be stored on the device or there would be a confidentiality agreement with the map provider. However, in the current implementation we note that the user will more often be requesting maps showing the location of other people whose identity is in no way conveyed to the mapping service.

Chapter 6:
Sharing Awareness via Category Rules and the LookAtMe

The Phonebook Categories used in the creation of Social Titles are also used as the primary way of configuring day-to-day access permissions. For example, you might like to specify that your work colleagues can see your social context from 9am to 5pm, Monday to Friday. It is probably safe to leave an automatic agent to manage broad access control rules such as these, as they are likely to be so few in number that one can remember having created them, and therefore be cognisant of the software's actions most, if not all, of the time. The LWT implementation of these category rules can be seen in Figure 7 (b) and (c). The time periods included in the system were prompted by the responses to 'Survey 2'.

However, in many circumstances (such as those mentioned in the Scenarios section of Chapter 1), users are also likely to want certain individuals to have short term access to a specific type of awareness information. In LWT, this type of fine grained management is done manually by the user. Even if we could build a system that allowed a user to specify, in advance, every possible situation in which each person can have access to the awareness information, Suchman [50] notes that people do not actually tend to devise formal, abstract plans and goals. Rather, people determine their action in any given circumstance by way of dynamic improvisation. This was also echoed, in the particular domain of privacy management, by Palen and Dourish [41].

In the LWT system, nuggets of fine grained awareness-granting are each encapsulated in an SMS-like message called a 'LookAtMe' (or LAM). A LookAtMe consists of a short text message, the type of access to be granted and the time period for which the access will persist. For additional efficiency of use, LookAtMe templates are also provided.

Users can request access to other people's awareness information implicitly by first granting access to their own. In this respect, the system may encourage people to 'give' in order to 'get'. When a LookAtMe is received, the user is presented with an easy option

to reciprocate and share the same type of information for the same duration. Of course users can also directly ask for access through some other communication channel.

Use of LookAtMes

A new LAM can be created from the Contact Status screen, a selected Contact in the Presence List, or from the Main Menu (by way of an intermediate 'Contact Chooser' list) as indicated in Figure 15. Figure 16 (a) shows the included templates available to the user and Figure 16 (b) shows the result of choosing one of those templates. The user can type a message into the text field just as they would an SMS. They also have the option to select which types of awareness information they are providing access to and for how long (Figure 16 (c)).
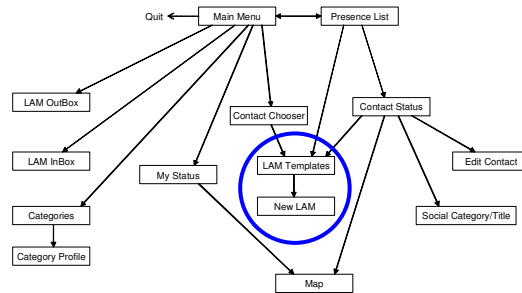
Figure 15

Location of the LAM Creation Screens in the LWT Navigation Graph

Figure 16

(a) LAM Templates   (b) New LAM Screen   (c) Choosing the LAM Duration

When an LAM is received, a vibration and audible chime alert is triggered. The user's
graphical view is not immediately interrupted, but on returning to the Presence List, a
visual summary of the LAM will be displayed (Figure 17 (a)). From this alert screen, the
user has the option to reciprocate by pressing the button marked 'Reply'. The result is a
screen for creating a new LAM that has been populated with information almost identical
to the LAM that was just received (Figure 17 (b) and (c)). The only significant difference
is that the replay message is prefaced with "RE-".

Figure 17

(a) Incoming LAM Alert   (b) Replying to a LAM   (c) Additional Duration Option

The Presence List and Contact Status screens indicate the existence of currently active LAMs (Figure 18). The 🐍 icon is used for sent LAMs, the 🐍 icon is used for received LAMs and the 🐍 icon is used when there is both an active sent and received LAM. The Presence List also uses the existence of an active LAM in determining the display order of the Contacts. Thus, the act of just sending someone an LAM actually helps to keep that specific Contact in focus.

Figure 18

A Contact who has sent the user an active LAM (Jaewoo Chung, left)
A Contact who is being sent an active LAM by the user (ChaoChi Chang, left)
Two contacts who have LAMs in both directions with the user (Matt Adcock, left and Paulina Silver, right)

An alternative way to view active and recent LAMs is via the LookAtMe InBox and LookAtMe OutBox which can be accessed from the LWT Main Menu (Figure 19). The LookAtMe InBox is shown in Figure 20 (a) and includes the most recently received LAMs. It is important to note that if a new LAM is received from a Contact it is considered an 'update' and simply replaces any pre-existing LAM. The LookAtMe OutBox is shown in Figure 20 (b) and includes the most recently sent LAMs. If the user wishes to cancel an LAM they can do it via this screen by selecting it and pressing the 'StopLAM' button.
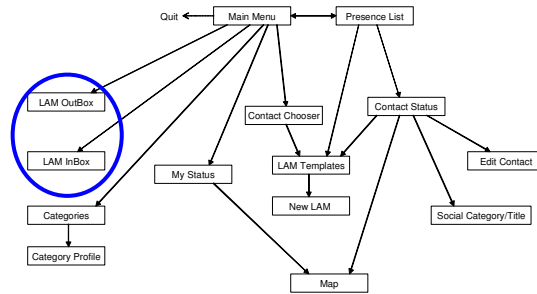
Figure 19

Location of the LAM Creation Screens in the LWT Navigation Graph
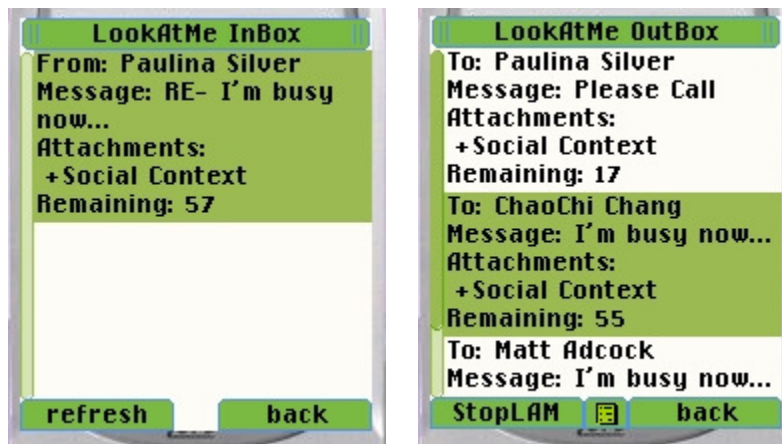
Figure 20

(a) The LookAtMe InBox   (b) The LookAtMe OutBox

Implementation of LookAtMes and Categories

The LAM Manager handles the sending and receiving of LAMs (see Figure 21).
Whenever a user composes and tries to send an LAM, the LAM manager builds a UDP
message of the form:

> **LWT.LAM.ACTIVE**:{local_IP}:{LAM_msg}:{LAM_type}:
>
> {duration_minutes}:{sequence_number}

The LAM_msg field contains the message typed by the user or inserted from a template.
The LAM_type field contains a bit-mask indicating the selection (or not) of the different

possible types of awareness information. The duration_minutes field represents the number of minutes (from the current moment) that the LAM is to remain active. This relative time value (like the together_seconds field of the **LWT.COMPANION.TITLE** message mentioned in Chapter 4) assumes near instant transmission time and is designed to avoid issues of clock synchronisation. The sequence_number field is used to identify an LAM for cancellation (as described below).

When an **LWT.LAM.ACTIVE** message is received, the LAM Manager will create and enter the information into an LAMInfo class which it stores in the respective Contact's ContextInfo. As mentioned above, new LAMs will simply supersede (i.e. overwrite) old ones. The LAM Manager also stores a local copy of the latest 'sent' LAM in the respective Contact's ContextInfo class. The LookAtMe InBox and LookAtMe OutBox lists are generated (when prompted by the user) by iterating through all the ContextInfo classes in the ContactDB. Additionally, the respective ContextInfo classes are checked for active LAMs whenever the Presence Manager or Location Manager need to determine whether to send awareness information. During both an InBox/OutBox iteration or an awareness information check, LAMs older than 24 hours are purged.

When a user decides to manually cancel an LAM (from the LookAtMe OutBox screen) the LAM Manager builds a message of the form:

      LWT.LAM.CANCEL:{local_IP}:{sequence_number}

This message follows the same path as the **LWT.LAM.ACTIVE** message (depicted in Figure 21). The receiving LAM Manager simply sets the 'end time' of the respective LAM to the current time.
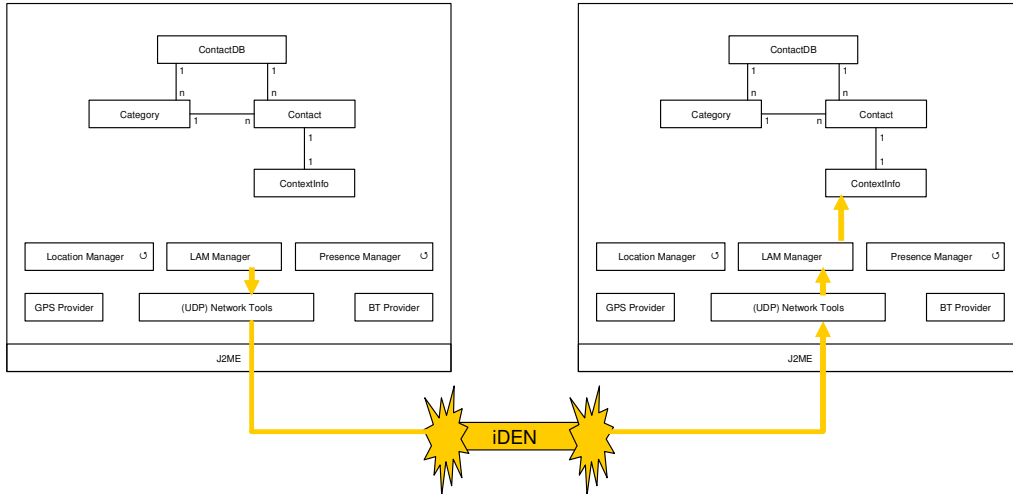
Figure 21

Module Diagram showing the path of an LAM message between two LWT systems

The category-based access rules are stored within the Category objects in the Contact database. When either the Presence Manager or the Location Manager wants to check if awareness information should be sent to a given Contact, the respective Category is consulted.

Issues with Sending LAMs via UDP

It is quite possible that a UDP packet will get lost and never reach its intended destination. This could happen simply due to the 'unreliable' nature of UDP[6], or it could happen because the receiver is not actively listening for UDP packets (e.g. the program is not running, or the device is switched off). Ideally, a system such as LWT should use a connection oriented protocol such as TCP to ensure messages are delivered. Alternatively, it should implement its own acknowledgement messages and spawn threads that periodically resend messages until those acknowledgements are received. We have however found that on the i870 phone, TCP over the iDEN data network can be quite unreliable. We have also found that more than a very few threads can be an excessive load on the processor. Lost packets are not as much of an issue for awareness information which quickly becomes 'old' and is replaced quite regularly.

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[6] Although UDP is designed with no guarantee of reliability, we have rarely noticed UDP packets going missing when sent within the Nextel iDEN network.

Chapter 7:
Evaluations

The LWT system was evaluated in three ways (in addition to the surveys mentioned earlier). The first was through a trial use of the prototype within the Speech and Mobility Group[7] at the MIT Media Lab. Obviously this project would gain most benefit from a longitudinal study. However, given the time and resources available, this was not possible. Specifically, this made it difficult to properly evaluate the use of the LookAtMe feature, which is geared heavily towards circumstantial use.

For the second and third evaluations the LWT system design was held up against design guidelines produced during two other research efforts. The first of these was developed by Oulasvirta et al. [40] for their 'ContextContacts' project. The second set of guidelines is the 'five pitfalls for designers' from Lederer et al. [32].

Use of LWT Prototype within Speech and Mobility Group

The biggest issue for users was remembering to turn the system on and to carry it about their person. For most of the group members, the LWT program was running on a device that was not their primary cell phone. A study by Patel et al. [42] showed that even though we may believe we are able to keep our primary mobile device within 'arm's length' at all times, the best proximity level they observed was 85%. They suggest caution when using the phone as an all encompassing proxy for the owner. Their findings were, however, encouraging when considering the overall design of the LWT system. They found that the phone is more likely to be with the user when they are outside of their home. If the home is the primary exception, then perhaps other ways of detecting domestic activity could be employed.

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[7] This trial included the author and the primary thesis supervisor.

Similarly, members of the group had to pay special attention to making sure the AGPS antenna could see the sky. This was often accidentally neglected. One potential modification to the LWT system would be to include an indication of the age of location information. That way, receivers of the information would be much better able to judge if the information they are viewing should impact their own actions.

Members of the group primarily used LAMs as a way of saying "Look where I am". This seemed to be partly due to the novelty factor of being able to brag about one's location without the overhead of a full phone call.

As mentioned in Chapter 4, the Bluetooth scanning had trouble seeing every device in a single scan while at the Media Lab. The system seems to perform satisfactory scans when tried in busy shopping areas or at airport terminals where on the order of 10 devices were typically detected.

Design Requirements for Mobile Awareness from Oulasvirta et al.

The 'ContextContacts' system by Oulasvirta et al. [40] aimed to introduce awareness information into aspects of current mobile phone use. Their design process was based on principles of social psychology (which they describe as a "mother discipline" of HCI). As a byproduct of this process, they produced a set of eleven Design Requirements, each directly related to a specific Social Interaction Phenomenon. Requirements 1 to 5 relate to the ways in which we perceive other people, 6 to 8 focus on managing privacy and self-disclosure, and 9 to 11 are concerned with "interaction on the move". In this section we address each of these design requirements by considering the relevant elements of the LWT system.

1. People as cognitive misers
Social Interaction Phenomenon: People do not usually engage in effortful conscious processing of cues

Design Requirement: Integrating judgment support to learned

	communicative practices in order to minimize cognitive load
Look Who's Talking:	Most of LWT's features have a mapping back to existing practices. The system's main screens are heavily based on a phone-book metaphor. The LAMs are created and viewed in a similar way to SMS messages. Maps are used to display location information. Additionally, people in the Presence List are represented by individual icons, usually photos of their face – which is how we recognize people in the real world. There is, however, some new learning needed to understand the context icons, and the idea that temporary persistent access can be attached to an LAM message.

2. Veridicality[8]

Social Interaction Phenomenon:	Veridicality of cues is necessary for accurate social attribution
Design Requirement:	Indicating veridicality and non-veridicality as well as timeliness of cues to user
Look Who's Talking:	In the event that a remote party stops transmitting, LWT will grey out the context icons after a predetermined timeout (5 minutes in the prototype system). This therefore protects the viewer from seeing 'stale' information.
	While we agree that some veridicality is important for the utility of an awareness system, we also note that there can be benefits in the plausible deniability afforded by some degree of ambiguity [3, 24, 38]. LWT exhibits this to some extent in the form of its

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[8] The "Veridicality" of a representation is the extent to which it truthfully corresponds to the actual situation being represented.

rather slow update rate.

3. Relevance

Social Interaction Phenomenon: Relevance of cues for the intended social attribution task is necessary

Design Requirement: Selecting informative cues of for typical mobile collaboration situations

Look Who's Talking: Simple colored (human-like) icons are associated with numbers of co-located companions. Text is used to display Social Titles as we receive other aspects of people's daily narrative in words (rather than pictures). The co-presence timing information is displayed, in minutes, adjacent to the Social Titles.

Maps are used for location information. One valuable aspect missing is the ability to create and display names for regularly visited locations. This is addressed in the future work section of Chapter 8.

4. Meaningfulness

Social Interaction Phenomenon: Cues are interpreted by using preexisting knowledge on them and on the situation

Design Requirement: Using meaningful and familiar context labels instead of raw sensor data

Look Who's Talking: The use of meaningful labels is the driving motivation behind the Social Titles concept. The second survey we conducted provides some evidence that people can use the Social Titles (and even just the number of proximate people) of a person's companions to form a judgment about that person's situation. They are also likely to use that information when deciding on a future course of action. The timing information presented with the Social Titles is similarly designed to

help the user form a judgment about the respective person's context.

Additionally, location data is presented in a zoomable map format so as to provide a broader context when necessary.

5. Associative learnability

<u>Social Interaction Phenomenon</u>: Possibility for associative learning of cues' relationship to real situations is important

<u>Design Requirement</u>: Providing more information on the cues upon request

<u>Look Who's Talking</u>: The LWT system consists of the main Presence List, and then a more detailed view of each contact.

The Social Titles (and, to some extent, the location maps) are designed to correspond to the titles used in everyday conversations. In this case, the "more information" is the memory and prior knowledge of the respective person.

The 'My Status' screen also provides a self-view and can be used to learn how various personal situations are presented by the system.

6. Self-Awareness

<u>Social Interaction Phenomenon</u>: Awareness of how the Self is displayed to others is needed for management of self-disclosure

<u>Design Requirement</u>: Representing to user how others see him/her at the moment

<u>Look Who's Talking</u>: The 'My Status' view of one's own presence information is available from the main menu. This depiction is of the same form as that seen by someone else who has full access to your awareness information.

The 'What They Call Me' feature of the Social Title

setting screen shows the user how they are being portrayed by others.

Category based access rules are small and relatively easy to remember. LAMs are explicit, temporary and can be reviewed in the LAM InBox and LAM OutBox.

7. Reciprocality[9] of self-disclosure

Social Interaction Phenomenon: People tend to disclose to others as much they disclose to them

Design Requirement: Providing mechanisms for the quick adjustment of disclosure of cues according to what others share

Look Who's Talking: Reciprocity is inherent in LAMs. The 'Reply' mechanism provides very easy and direct reciprocation in response to another person's granting of some type of access. There is also a subtle, involuntary degree of reciprocity when an LAM is sent. In that case, the receiver is elevated on the Presence List of the sender - regardless of whether they are transmitting awareness information or not.

If a user switches off the application altogether, there is a 'reciprocity of zero' in that neither party can see each other's context information.

We note here that this design requirement does not require a strict reciprocity – only that the mechanism be provided. This is an important part of the LWT system. People are in control of their own information disclosure and do not automatically send to someone as a result of themselves receiving information.

8. Control

Social Interaction Phenomenon: Self-disclosure is often controlled situationally for each

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[9] "Reciprocality" is synonymous with "Reciprocity" and relates to a mutual exchange of gifts or privileges.

group/individual

<u>Design Requirement</u>:	Providing mechanisms for controlling the disclosure of cues to individuals and groups
<u>Look Who's Talking</u>:	The Category access rules provide mechanisms for regular/ongoing disclosure to groups of people. The LAMs are a mechanism for providing (or elevating) access to individuals on a moment-to-moment basis. It is possible in the current prototype to make a category with only one member in the event that the user wants to provide an ongoing rule for a specific individual. There are currently no mechanisms for sending LAMs to every member of a category, however this feature is mentioned in the future work section of Chapter 8.

9. Temporal organization of social processes

<u>Social Interaction Phenomenon</u>:	Turns, rhythms, and paces structure mobile interactions
<u>Design Requirement</u>:	Providing timely information on others' turns; supporting rapid responses
<u>Look Who's Talking</u>:	LAMs are conveyed practically instantly and received at the other end with an alert. There is also a record of LAMs in the LAM InBox and LAM Outbox and these act as a partial record of recent activity. LAMs also include a mechanism for 'rapid' two-button-press responses.
	All other information in the system is generated on a scale of 1 to 5 minutess and displayed in the Presence List with a latency of at most 20 seconds. Network latency (of UDP messages) is generally in the order of tens of milliseconds.
	The numbers above are not ideal and we consider that this design requirement is not properly fulfilled by the

current prototype. Concerns about power consumption by the mobile device have been somewhat traded off against the temporal resolution of social interaction. It is hoped that the next generation of mobile handsets will allow this to be less of a concern.

10. Limited cognitive resources due to multitasking

Social Interaction Phenomenon: Cognitive resources available for HCI are limited due to multitasking

Design Requirement: Supporting rapid visual search for cues; minimizing cognitive load and the need for task-switching

Look Who's Talking: Icons and photographs are used in LWT as visual cues to aid rapid visual search.

The contacts who are most actively transmitting, and those with whom the user has had some recent interaction, are grouped towards the top of the Presence List for quick on-the-go access.

The integration of LWT with the Contella Framework and with existing phone systems (such as the ability to make a phone call) reduces the need to switch between applications.

11. Temporal acuity

Social Interaction Phenomenon: Mobile multitasking requires careful temporal orchestration of actions

Design Requirement: Designing for short interaction chains; duration of interaction must be very brief or interactions postponable

Look Who's Talking: LWT separates configuration tasks (such as managing Contact Categories) from the daily tasks that require very fast action (such as viewing awareness information or sending an LAM).

There are 'hot button' commands on most screens and, in the case of LAMs, predefined templates. An LAM can be sent from the Contact Status screen with as few as three presses of the same button (plus the use of the down arrow, if a template is to be selected).

As can be seen in Figure 2, the navigation chains are at most only ever three screens deep. Wherever possible, the design follows GUI principles that are similar to the existing applications on the i870 handset.

The Five Pitfalls of Personal Privacy from Lederer et al.

During the design of the *Faces* system [32], Lederer et al. explored a number of privacy related issues that had also been reported by previous research efforts. To help future designers of similar systems, they formalised these issues into their 'five pitfalls for designers' of privacy-affecting interactive systems.

While Lederer et al. do not claim they have found all the answers to making sure a system properly deals with all privacy concerns, they do claim "that systems that ignore any of these guidelines without careful rationale face significant risk of disrupting or inhibiting users' abilities to manage their personal privacy".

Pitfalls 1 and 2 relate to issues that primarily affect users' understanding of a system's privacy implications. Pitfalls 3 to 5 are concerned with the users' ability to conduct socially meaningful action. In the remainder of this section we note the ways in which LWT strives to avoid these pitfalls.

1. Obscuring potential information flow.

Pitfall: Designs should not obscure the nature and extent of a system's potential for disclosure. Users can make informed use of a system only when they understand the scope of its privacy

implications.

Look Who's Talking: The LWT system allows users to always see their latest detected company, their current location (on a map), and a rendering of how they are represented to other people using the system. All of these features help the user to fully appreciate the extent of the information that can be divulged.

2. Obscuring actual information flow.

Pitfall: Designs should not conceal the actual disclosure of information through a system. Users should understand what information is being disclosed to whom.

Look Who's Talking: The Category configuration screens show the coarse grained permissions and the LAM InBox and OutBox provide a reference of recent LAM activity. Between these two, the user can see everything that is currently set to be disclosed. Although the user may assume that this is the information with the potential to be sent, it is not correct to assume that the information is actually being received and/or seen by anyone. There may be some instances in which an LAM's sender believes they have cancelled an LAM, while the receiver of the LAM thinks it is still valid (e.g. because their phone was powered off at the time of the cancellation message). In this sort of situation there is no 'concealing' of actual information disclosure, however there might be some additional information that gives the impression that more information is being received than is actually being sent. As mentioned earlier in this thesis, an extra layer of acknowledgements in the LAM protocol would solve this, but was not included in the prototype due to concerns of power consumption and parallel threading.

3. Emphasizing configuration over action.

Pitfall: Designs should not require excessive configuration to manage

privacy. They should enable users to practice privacy as a natural consequence of their normal engagement with the system.

Look Who's Talking: Contact Categories are already a staple of many phones, PDAs, PIMs, etc. and are often used to focus the user's view on subsets of contacts, send group messages, and manage ring tones. It is envisaged that the Categories used for controlling presence information in LWT could easily leverage existing category mechanisms.

The default in LWT is that no one has access to the user's awareness information and any non-LWT activity will not result in the user's context information being disclosed.

4. Lacking coarse-grained control.

Pitfall: Designs should not forgo an obvious, top-level mechanism for halting and resuming disclosure.

Look Who's Talking: The main menu provides a 'Mute/Un-Mute' option that affects all outgoing transmissions of awareness information. This can be used in cases where the user wants 'absolute' privacy. Also, the user can always stop the software from running.

5. Inhibiting established practice.

Pitfall: Designs should not inhibit users from transferring established social practice to emerging technologies.

Look Who's Talking: The pseudonymous nature of Social Titles mirrors the way we often expose our relationships in daily narrative. LWT also allows any (short) text string to be entered as a Social Title. Similarly, the text field of an LAM is freeform and doesn't proscribe any specific format.

There is a parallel between the ad-hoc peer-to-peer nature of a LookAtMe and both the self reporting we often do on the telephone or in person, and the constant micro-coordination that can often be achieved with SMS.

Plausible deniability exists to about the same degree as with SMS or other common asynchronous communication media (e.g. "I didn't look your context information recently"). There is also an extra layer of social deception possible with LWT by claiming that one's phone was left somewhere by accident while it was still scanning and transmitting.

Chapter 8:
Conclusion

Contributions

We have introduced the Look Who's Talking prototype, a system that demonstrates a new type of interpersonal awareness and mechanisms to manage access to such information. Specifically, the contributions are:

1. A new type of awareness information called 'Social Titling' that aims to communicate aspects of the user's social attention. Mechanisms for the authoring, sensing, transmission, and display of this information were presented. Two surveys were also conducted to investigate the likely nature of use and possible utility of Social Titling.

2. A new tool for the management of access to awareness information by arbitrarily large groups of acquaintances or by specific individuals. Contact Categories were presented as a way to manage a small number of broad access rules. An SMS-like message called a 'LookAtMe' (LAM) was proposed as a way to grant 'episodic access' to specific individuals when the need arrises.

Future Work

The LWT system has been built in a modular fashion within the Contella Framework. It is hoped that this will allow some of the parts of the system to be integrated with other existing and future applications based on this framework. One application in particular, called Will You Help Me [14], offers two specific functions that would directly complement LWT.

The first of these is Named Locations. In a similar fashion to the Social Titles, Marmasse and Schmandt [35] describe how a user's regular locations can be titled or named to provide meaningful and somewhat private descriptions. This was later included (in form

consistent with the Contella Framework) in Will You Help Me. If included in LWT, these location names could be included on the Presence List instead of the globe icon, removing the requirement to drill down two screen levels and load a map before getting a glimpse of the respective contact's location.

The second complementary function from Will You Help Me is the ability to detect and add contacts based on Bluetooth scans. This would mean that the device owner could find and add a co-present companion's details to their phonebook by quickly pressing only a couple of buttons. Additionally, Will You Help Me includes the ability to automatically collect contact details from devices that have a phone number already entered into the contact database.

One theme that emerged from the second web survey was that people seemed to place some importance on how rare or frequent a given social encounter was assumed to be. An indication of 'rarity' could be achieved in the LWT system either by automatically recording the duration and frequency of various social encounters, or by a manual rating system. Interfaces for the use of both of these options are already found in many music library applications for managing, sorting and finding music tracks. Such a feature may remove some of the need to indicate non-default titles. For example, the special title "Office Mate" may not be needed if the more generic "Co-worker" is accompanied by an indication that many hours each day are usually spent with that person. This sort of system may also somewhat alleviate the trouble people had when specifying who is just a 'work colleague' and who is also a 'friend'.

An area for further investigation is whether or not some people may wish to transmit the real names of their companions (instead of the respective Social Title(s)) to other members of a tight social clique. This could be implemented as a check-box option in the Contact Category setting screen.

LAMs, like SMSs should be able to be sent to groups of people. These recipients could be either the members of a chosen Contact Category or selected on-the-fly from entries in

the phonebook. Just as sending an individual LAM can act as an implicit request for access to a specific person's context information, a group LAM 'blast' could result in a quick way to gain access to, for example, guests who are on their way to an event you are hosting.

Ultimately, the LAM feature should be extensible and permit the attachment of other types of awareness information access. The Named Locations mentioned earlier in this section is one possible type of information, but there are many others. For example, the phone's profile (i.e. vibrate, silent, etc.) could be used. Alternatively, someone's 'spare time' as derived from their phone's calendar application could be attached. Also, as wearable medical and physiological monitoring devices become more prevalent, the transmission of their output to remote care takers could be managed via the 'episodic' nature of the LAM. It is worth noting however, that a system using more than two or three types of awareness information would require a rethink of the (currently straightforward) LAM authoring screen.

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