handiMessenger: Awareness-Enhanced Universal Communication for Mobile Users

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Abstract. Successfully contacting colleagues while away from the office is especially difficult without information about their availability and location. HandiMessenger is a service designed to facilitate opportunistic communication by tightly integrating awareness and contact capabilities into a wireless, unified messaging and awareness application. Users can securely access intranet email, instant messages, and other messages from a handheld mobile device (e.g., a wireless PDA). Simultaneously, they are presented with awareness information about the sender to enable a reply in the most appropriate mode, given the situation of the participants. For example, they can read email and reply by initiating a phone call, if the sender is available by phone. Analysis of handiMessenger usage shows that users do request awareness information while inspecting message headers or content, and that users also, at times, respond to a message with a different type or in a different mode than the original message.

1 Introduction

Cell phones, pagers, wireless PDAs, and laptop computers are designed to help people stay connected in today's mobile society. The use of these devices alone, however, does not overcome some of the common communication problems that many mobile corporate workers face on a day-to-day basis. These users may play constant "phone tag," since they often do not know when their colleagues are available, where they are located, or which devices are accessible to them. Enterprise users also deal with several problems in retrieving messages, such as email, when away from the office. For example, they usually need to deal with securely getting through a firewall. Currently, such access may require specialized hardware for added security purposes (e.g., a secure token generator, a Research in Motion (RIM) Blackberry device). Enterprise users may also experience difficulty in accessing urgent messages in certain social contexts (e.g., in meetings).

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HandiMessenger is an awareness-enhanced universal communication service for mobile enterprise users. This prototype service is designed to facilitate group and personal communications when away from the office. Users can easily access intranet web pages or their intranet messages from their wireless handheld device (e.g., such as a Palm VII or a WAP-enabled cell phone). Such access can be done unobtrusively in a meeting situation. Users can also request awareness information and use tap-to-contact links for quick and easy communication with colleagues. These awareness and contact features are tightly integrated with users' messages and message headers to provide opportunistic communication. That is, a user can check messages, view integrated awareness information to see if and how the message sender is available, and simply tap an embedded link to initiate communication with that sender. The usage logs confirm that such scenarios do occur in practice.

The following types of communication are supported within handiMessenger: intranet email, group instant messages, and click-to-dial on mobile phone devices. We also support a new type of message, namely ConnectIcons [1]. A ConnectIcon is an electronic correspondence that includes a brief message line, presence information about the sender and recipients, communication link(s) specified by the sender (e.g., email, phone, and/or instant messaging), and optional URL attachments. In addition, we recently added third-party call control to setup calls between two IP-based H.323 phones, calls between H.323 phones and standard PSTN phones, and calls between two IP-based Session Initiation Protocol (SIP) phones.

HandiMessenger is implemented as a web-based service with server-side processing and is thus easily delivered to a variety of users' existing handheld devices. We tested handiMessenger with a variety of mobile devices, including several Palm-based devices, PocketPC device with wavelan (802.11) card, and WAP phone with GPRS service.

HandiMessenger also provides a mobile complement to TeamPortal [1], a Java-based portal designed to aid teams in communication and coordination. TeamPortal provides a visual GUI to calendar and awareness information, click-to-contact links, connectIcons and group instant messaging (IM). Thus, when a calendar entry or group IM is updated through handiMessenger for example, this update is automatically propagated to users logged in to TeamPortal.

The main contribution of this work is a service that provides opportunistic communication by transparently integrating awareness and communication capabilities into a messaging application. More specifically, we have: embedded awareness information and communication functions into the display of message headers and content, calendar, and corporate directory listings; added persistent instant messages to the family of unified messages; incorporated an infrastructure to securely access intranet information from wireless, web- and internet-capable handheld devices; incorporated third-party communication initiation where appropriate; and used a commercial communication infrastructure to initiate voice calls between various types of endpoint devices (including standard telephone and voice over IP devices—i.e., PSTN, H.323, and SIP). Analysis of handiMessenger usage logs shows that users most frequently use the service just to obtain the latest message headers, or to obtain headers and then retrieve a message, thus indicating the utility of the awareness and other information provided on the message header page. The logs also show that users sometimes replied to a message in a different mode

from the received message and that they also made awareness requests from the context of both message headers and message content.

The remainder of this paper is divided into five additional sections. In the next section, we present sample scenarios on how handiMessenger can be used. We then describe the system architecture and key functionality. This is followed by a discussion of handiMessenger usage and user feedback. Finally, we discuss some related work and present our conclusions.

2 Sample Scenarios

A common situation when handiMessenger is useful is when one or more colleagues travel out of town on business (e.g., to attend a conference). In the corporate world, users typically need to get through a firewall to access their messages. For many users, this could mean using a local network and setting up a virtual private network (VPN) connection, or traveling with larger devices such as laptops and going through a series of several steps to connect to the corporate intranet (e.g., using an 800 number, entering access codes, etc.). Although devices such as the RIM Blackberry and services such as AvantGo provide secure email and limited intranet web access from a wireless handheld device, these applications and hardware platforms do not provide access to universal messaging nor do they integrate awareness information.

Assume Diane is attending the CHI'2001 conference. Using a Palm VII, she can simply raise the antenna of the device, start handiMessenger and specify the type and number of messages to retrieve. She is presented with a list of her messages along with available awareness information of the message senders. She decides to click on an email from Dave because she sees that he is currently logged into TeamPortal. Dave wants to know how the conference is going. Diane decides to respond by tapping on Dave's office phone icon to initiate a voice call between her hotel phone and Dave's office.

3 System Description

3.1 Overview

HandiMessenger is a web-based service, the core of which is implemented as a set of Java servlets. The "home page" for the handiMessenger service is a web page that has been installed onto a user's wireless PDA (e.g., a Palm Query Application (PQA) installed on a Palm VII). Devices that do not support installation of PQAs, bookmark a reference and each time the initial page is downloaded or retrieved from the device cache. The top of the handiMessenger home page is presented in Figure 1.

Starting with the handiMessenger home page, users can access the service to check various types of intranet messages or initiate various modes of communication. For example, users can check corporate email, team-based instant messaging (IM), and

other types of specialized messages such as connectIcons. They can also use handiMessenger to examine awareness information about various team members and initiate communication through handiMessenger's simple "tap-to-contact" links.

Fig. 1. Top part of the handiMessenger home page

3.2 Architecture

The handiMessenger architecture is presented in Figure 2. A handiMessenger request from a wireless PDA is transmitted over the air to a nearby cell tower and then relayed through a proxy of the wireless service provider (e.g., service providers such as OmniSky or Palm.net) to the handiMessenger gateway (i.e., external server). Inside of a corporate intranet, handiMessenger pools for requests from the gateway via an https tunnel through the corporate firewall (using a corporate https proxy).

When a request is received, handiMessenger authenticates the user, processes the request, and uploads the result to the gateway using the https protocol. At the gateway, the HTML content is filtered to rewrite all intranet references. The results are then sent back to the user's device. The following basic handiMessenger requests are currently supported:

- getMessageHeaders,
- getMessage, composeMessage and sendMessage,
- getCalendar and setCalendar,
- getAwareness, and
- getCorporateDirectoryListing.

When processing a user's request, handiMessenger uses standard protocols to gather information from various messaging and awareness servers and/or other corporate databases or URLs as is necessary to fulfill the request. User authentication to these other servers are set up by the user ahead of time, during a one-time provisioning session. This provisioning is similar to specifying mail server and login information for Netscape Messenger.

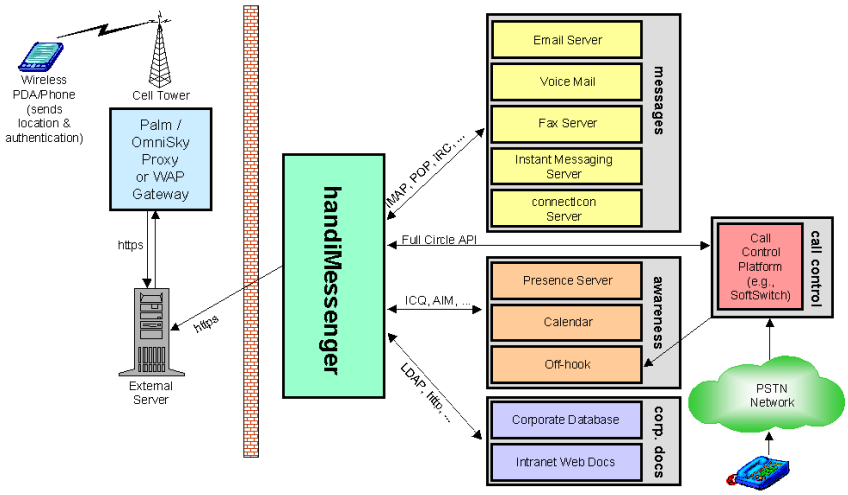

Fig. 2. handiMessenger Architecture

3.3 Checking Messages

When using handiMessenger to check for messages, users can select the type of messages to retrieve, along with the maximum number of messages to check. A list of message headers is then presented to the user, sorted by the order in which they were most recently received. This is similar to a list of email headers presented when reading email, only all selected types of message headers are included in the list (i.e., in addition to email). On the left of each message header in the list, an icon is used to indicate the type of message. These are the same icons displayed on the handiMessenger home page and shown in Figure 1. A sample list of message headers displayed by handiMessenger is shown in Figure 3.

The message headers summarize typical message information such as:

- *Date:* the date or time for the message. If the message was received today, only the time is shown, in order to save space. For email, the date displayed is the date that the email was sent. For group instant messaging (IM), the date of the last chat line is displayed.
- *Subject:* the subject of the message. Similar to the Palm OS email reader, the subject line is truncated to a few letters to save screen space while still providing a hint of the message subject. For group IM, the subject line includes the user ID and beginning text corresponding to the last chat line added.
- *From:* an indication of who sent or updated a message. If awareness information about a sender or group is available, an abbreviated version of the presence information involving the last device used is displayed underneath their email address or group ID. This enables users to see at a glance who might be available for them to contact immediately.

Fig. 3. Message headers shown by handiMessenger

Users can click on a message subject to retrieve the body of the message. They can also click on a sender's name to get more detailed awareness information about that person. The "key" icon at the end of each link indicates that the link is a secure https link. This icon is automatically added by the Palm OS web clipping application.

When handiMessenger retrieves the contents of a message, the system annotates the message with awareness information and tap-to-contact links. Thus, when users read a message, they can see if the sender is currently available and easily contact them via any one of the sender's available devices. Users are thus not constrained to reply to a message in the format in which it was sent, but they can easily mix various communication modes (e.g., phone call in response to an email message) according to their preference and the party's availability.

3.4 Checking Awareness and Initiating Communication

HandiMessenger provides access to awareness outside of checking messages. From the handiMessenger home page, users can request awareness about registered individuals or groups, or look up individuals from the corporate database. Based on the information presented, users can then contact the desired party or parties via handiMessenger's tap-to-contact links. For example, they can click on a phone icon to initiate a phone call with someone.

An example of awareness information about the handiMessenger group is shown in Figure 4. The top of the page provides iconic links for initiating the following types of group contact: email, group IM, connectIcon, and conference call. Thus, clicking on the envelope email icon will bring up an email composition page with the emails of all group members inserted into the "To:" field; clicking on the talk bubble group IM icon will display the persistent group IM session, and so forth.

Following the group contact icons, group members are listed alphabetically by user ID. When group awareness is requested, all members are displayed. When individual awareness is requested, only that person's information is presented. In either case, the individual's awareness information is presented in the same format. Each member's

email address is displayed next to their ID. This is followed by a list of their available devices, sorted by when they were most recently used. Each device line includes:

- an icon indicating the type of the given device or application (a door icon represents TeamPortal),
- a letter indicating the location of that device (w=work, h=home, o=other)
- abbreviated time information to indicate how long ago the device was updated (e.g., 10s=10 seconds),
- information about the current status of the device.

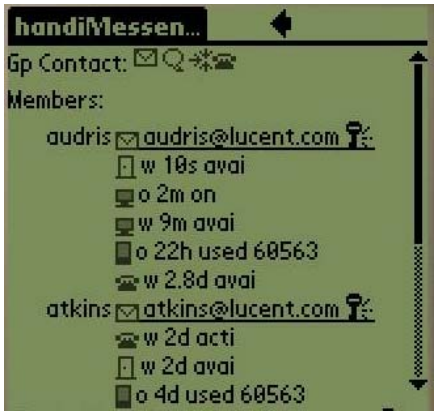

Fig. 4. Sample group awareness information displayed by handiMessenger

In the case of PDA devices, zip code information of the closest tower to where the device was last used is also presented, when available. When combined with the access time indicated, the zip code can indicate whether a group member is currently in or out of town, and could thus influence a decision on how to contact that member.

3.5 Implementation and Current Status

As mentioned above, the core of handiMessenger is implemented as a set of Java servlets. For Palm OS-based devices, the handiMessenger icons and home page are installed as a PQA application directly onto the user's wireless PDA. Individual user information and provisioning are saved in an LDAP database. We currently support access to email, group instant messages, and connectIcons. We also support third party call control over traditional (PSTN) and IP-based phones such as H.323 and SIP endpoints. The call control features related to traditional phones require additional communications setup, such as a Lucent SoftSwitch, however.

handiMessenger has been running since April 2001. During the summer of 2001, we tested its use within our research group and gathered some additional feedback from some business unit partners.

4 Usage and User Feedback

4.1 handiMessenger Usage

A typical usage pattern within handiMessenger is to:

- list message headers,
- retrieve the body of one or two messages,
- reply or compose a short message.

Based on PDA constraints and bandwidth, mobile users are not so interested in reading the details of all of their messages, but more likely to look for messages with higher priority or those requiring some sort of timely response. Since most PDAs are not very conducive to composing long messages, users tend to either keep their communications brief or turn to a device with a higher bandwidth (i.e., the phone).

4.2 Analysis of Usage Logs

We collected usage logs at the server side, where we recorded user id, user location (ZIP code), request URL, and the content of the request. We did not collect information at the client (PDA) side so we can only reconstruct over-the-air request sequences, and not navigation between application pages on the PDA itself. That is, pages are cached on the PDA, so a user could get message headers, get a message, use the back button to review the cached headers, and then request to get a different message; such an interaction would result in three (not four) over-the-air requests.

In this section, we discuss preliminary results of handiMessenger usage based on logfile analysis of trial usage of the service. Our goal was to understand basic usage patterns and to use this information to refine the handiMessenger interface. The voice communication capabilities of handiMessenger were available only at the very end of the period, so we do not have sufficient data to analyze their usage. To insure uniformity of the data, we consider only the period before the voice call capabilities (via 3rd party call setup) were introduced.

Types of handiMessenger Requests Made. From April until August of 2001 there were 1428 over-the-air requests by ten users made from 34 different zip codes. Figure 5 summarizes the distribution of the most frequent requests.

The most frequent handiMessenger request was getMsgHeaders; the next frequent requests were getMessage, followed by getAwareness, composeMessage, sendMessage, getDirectoryListing, and getCalendar. This indicates that users were mainly concerned about obtaining their latest message headers and reading some of their messages. Also, since full awareness is automatically presented with getMessage requests, users did not need to make as many separate getAwareness requests. Out of the 337 total getMessage requests, 251 were to read email, 56 to see instant messages, and 30 to retrieve connectIcons.

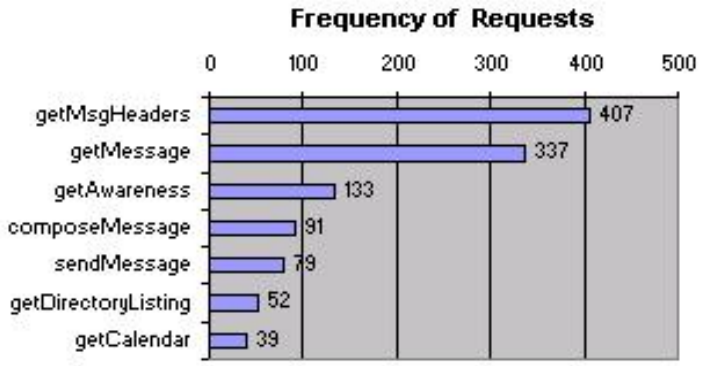

Fig. 5. Distribution of most frequent handiMessenger requests from April to August 2001

Sequences of handiMessenger Interactions. We analyzed sequences of handiMessenger interactions in order to better understand how the service has been used. We first extracted sequences of interactions by breaking the full sequence of a user's accesses into subsequences at the points where the delay between two accesses was more than five minutes. In our data, there is no significant difference between the number of sequences when using a delay of one to nine minutes. There were 333 such sequences of user requests, with about 75% of the sequences shorter than four accesses. The frequency distribution of sequence lengths is shown in Figure 6.

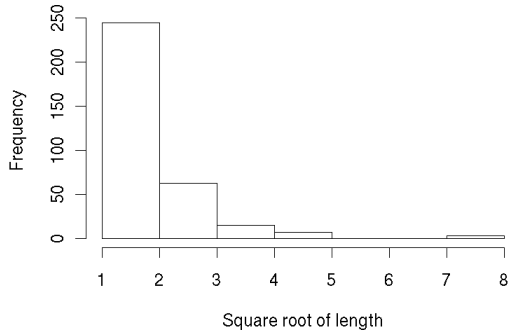

Fig. 6. Frequency distribution of session lengths, by square root of length. The majority of sessions only made one to three over-the-air requests.

One-step sequences accounted for 26% (these were mostly getMsgHeaders requests) and two-step for another 21% of all sequences. This means that roughly half of the time, users make only one or two requests (where getMsgHeaders, or getMsgHeaders followed by getMessage were the most frequent among these). Based on this, we hypothesized that users are not relying on handiMessenger as a primary messaging program (e.g., for reading *all* email), but they are likely just using it to check if any new messages require more immediate attention. Direct feedback from users confirmed this hypothesis.

Table 1 summarizes transition probabilities for handiMessenger sequences. The Table shows that after reading headers, users are likely to:

- read messages (59% of the time),
- get headers again (30% of the time), or
- check the sender's full presence (11% of the time).

Table 1. Transition probabilities between frequent handiMessenger requests

	To:			
From:	**getHdrs**	**getMsg**	**getAwr**	**compose/ sendMsg**
getHdrs	0.30	0.59	0.11	0.00
getMsg	0.07	0.61	0.09	0.23
getAwr	0.14	0	0.42	0.44

The logs show that when users get headers again, they are either refreshing the header listing (e.g., to check for any new messages), changing the number of headers retrieved (e.g., to get more headers), or requesting a different collection of message types to be shown (e.g., accessing instant messages and connectIcons instead of just email). When users check the presence of a message's sender, they are retrieving the full presence information available for that sender, versus the minimal presence information that is automatically displayed with the message header. The zero in the right column of Table 1 reflects the fact that it was not possible to respond without looking at the message content first. While we do not know whether or not the decision to respond to a message was taken based on the presence information, the 11% of the time users chose to investigate presence information in more detail suggests that it is worth providing it at the message header level.

Table 1 also shows that after reading a message via a getMessage request, users are 61% likely to place a subsequent request to read a message. Further analysis shows that 70% of time it is a request for a different message and 30% of the time it is a request for the same message, but with complete content. Users are 23% likely to compose or send a message after reading a message (e.g., to reply to email or add to an IM session). They may also check presence or refresh headers after reading a message, but this occurs less frequently. This indicates that on a low-input-bandwidth device such as PDA, composing text messages is not frequent (note that the data does not reflect tap-to-call functionality, though).

Based on Table 1, we also see that detailed awareness information (from "getAwareness") is used as a step to initiate a communication of the most appropriate mode (44% of the time) or to check awareness of several people (42% of the time). This supports our conjecture that making presence available in multiple contexts may increase the likelihood of communication.

Replying to Messages. We also analyzed the usage logs to identify how users reply to the messages they receive. Email is the most likely response to email, although there were instances when a connectIcon or an instant message was used to reply. The same holds true for instant messages (i.e., an instant message is the most likely response to an instant message). For connectIcons, the most likely response was an instant message (it makes no sense to send a connectIcon back). Although there were

relatively few cases of such response sequences overall, we do see that users do not feel that their response messages need to be of the same type as the originating messages they received.

We believe that the addition of click-to-dial and third-party call control will be frequently used by handiMessenger users in the future. We expect this to be especially true in situations where users need to provide longer replies to messages. Current PDAs are not conducive to lengthy text input, and thus users are less likely to use them for composing long messages. This is also in line with a study of IM in the workplace, which showed that IM often transitions to a wider bandwidth communication channel [5]. However, the switch to wider-bandwidth devices such as the phone is also limited to particular contexts. We would not, for example, expect users in a meeting situation to interrupt an ongoing meeting by initiating a phone call. The study of such usage patterns thus needs to be conducted in additional detail in the future.

4.3 User Feedback

Six users completed a user survey on the utility of handiMessenger, its current features, and possible future features. The users indicated the utility of easy intranet email access, the value of an integrated service, and the desire for future features. Details about their feedback are provided in the remainder of this section.

Easy Access to Intranet Email. An important feature of handiMessenger is secure access to corporate email from outside of a firewall. Although other commercial products support this, many of these have hardware or software constraints at the client or server level. The RIM Blackberry, for example, constrains access to email from a particular device. Users who already own popular Palm-based devices may be reluctant to switch to another device or unwilling to carry an additional one. Some services also require a particular email server, such as Microsoft Exchange. Many corporate end-users do not have control over their email servers, which are typically maintained by a centralized systems support team.

HandiMessenger only requires the availability of a standard POP3 or IMAP interface from an existing email server. The service also can be accessed from a number of handheld devices, including Palm OS-based devices and PocketPC devices. HandiMessenger has been used from a variety devices, including: Palm V or HandSpring Visor with OmniSky modem, Palm VII and VIIx, Kyocera SmartPhone, Compaq iPaq with waveLAN card, and Motorola Timeport 260 phone with WAP over GPRS service.

No Need for Context or Application Switching. Although users appreciated easy access to email, they also liked the ability to select the types of messages to retrieve, along with the ability to reply via various modes of communication. In handiMessenger, users do not need to switch to different applications to access different types of messages. Also, the integrated awareness information provides insight into how one might successfully contact the message sender. Finally, the tap-to-contact links provide easy access to alternative communication modes.

Pending Issues and Requests for Future Features. While users were generally pleased with the existing handiMessenger features, they also had some concerns and requests for future features. Some of these requests included the following:

- ability to control awareness information for privacy,
- desire to receive notification about incoming messages,
- text shortcuts to improve efficiency in text input (e.g., for writing an email or IM),
- ability to add filters to focus on specific messages,
- translators for attachments (e.g., such as for a Microsoft Word file attached to an email message).

5 Related Work

The explosion of instant messaging, the convergence of voice and data networks, and the fast-paced evolution of wireless devices are opening up new avenues for coordinating and staying in touch with colleagues. Although awareness research has been going on for years (e.g., especially related to video awareness such as in [2]), it has only recently begun to go mobile (e.g., see [4, 7]).

Hubbub supports mobile instant messaging with novel sound features [3]. Short musical tunes are used to indicate when users are present, as well as to communicate short messages. Users can login on a desktop or send and receive instant messages from a Palm OS device with a designated IP. Hubbub also allows users to login to the system from as many places as they wish (e.g., home or office PC, or Palm device) and the system automatically "follows" users according to their current or most recent interaction with the system—thus updating presence information appropriately. Hubbub does not integrate other types of group communication, however.

iMobile is a proxy-based platform for mobile services [6]. The platform provides a messaging-based service where messages are relayed between various mobile devices or between information servers and these mobile devices. The approach can be thought of as using an instant messaging window (e.g., such as that found in AOL) to either send messages to other users or to treat any message as a kind of shell command. Thus, when users open an instant messaging session with an iMobile agent, they can send messages that request information such as the quote of a stock, airline flight information, or the weather. Email can also be accessed in a command-line like fashion. The key feature of the iMobile platform is that new endpoint devices or new services can easily be added without changing the overall service logic. Although iMobile does not currently support a service such as handiMessenger, we believe that handiMessenger could be ported to run on top of the iMobile platform.

Awarenex [7] is perhaps the mobile messaging application that is most closely related to handiMessenger. In Awarenex, users start with awareness information in the form of a contact list (i.e., a kind of "buddy list"). Using this list, users can click on an individual in the list to get more detailed contact information. The user is then presented with the "Contact Locator," where they can get information about an individual's likely location, based on usage of their various registered devices (e.g., office phone, mobile PDA, home computer, etc.). We display similar information

within handiMessenger on our individual and group awareness screens. From the Contact Locator of Awarenex, users can click on an email address to send email to the person, or click on a device to initiate either a phone call or instant messaging session with the person. We also support these types of click-to-contact links within handiMessenger. Awarenex, however, does not support the *retrieval* of various types of messages such as email. Awarenex also does not support the notion of groups or persistent group chat. All instant messaging is done one-to-one within Awarenex, versus one-to-many. We thus feel that handiMessenger provides better support for team-based communications.

Internet services such as Yahoo are moving towards integrating limited presence information with email and group correspondence. For example, when users view one of their Yahoo emails, a smile icon indicates whether another Yahoo user is logged into Yahoo Messenger (Messenger includes chat). However, this presence information does not provide more detailed awareness nor is it displayed in the context of email headers.

6 Conclusion

handiMessenger is a novel service that provides mobile access to awareness-enhanced communication from a wireless PDA. Users can access intranet email, group instant messages, and connectIcons without having to switch contexts from one application to another. Awareness information about a message sender supports users in making opportunistic connections with their colleagues. Users are not constrained to the mode of communication in which they are accessing a message, but can easily follow tap-to-contact links to initiate alternative modes of communication. Thus, for example, users can (and do) access a connectIcon and reply via phone or email.

Analysis of usage logs shows that users most frequently used handiMessenger to obtain the latest message headers, or to obtain headers followed by obtaining the message content, thereby using message headers as a filter to determine if they have to take any urgent action in replying to a message or in contacting a currently available colleague. The logs also showed that users have taken advantage of other unique features of handiMessenger, including requesting awareness information after viewing message headers, or replying to messages in a different mode from the received message.

Users of the handiMessenger service appreciated easy, mobile access to corporate email, the ability to stay better connected with their team members, and the consistent access to different types of messages. They did, however, also express concern for privacy issues and requested additional features such as message notification, filtering, and translations for attachments. We plan to address some of these issues in the future.

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