Platforms and standards for these services must anticipate and accommodate future developments.

JOHN C. TANG, SUN LABS
JAMES "BO" BEGOLE, SUN LABS

Beyond Instant Messaging

The recent rise in popularity of IM (instant messaging) has driven the development of platforms and the emergence of standards to support IM. Especially as the use of IM has migrated from online socializing at home to business settings, there is a need to provide robust platforms with the interfaces that business customers use to integrate with other work applications. Yet, in the rush to develop a mature IM infrastructure, it is also important to recognize that IM features and uses are still evolving. For example, popular press stories[1] have raised the concern that IM interactions may be too distracting in the workplace. This concern suggests that we still need to fine-tune the interface design for IM so the benefits of quick, lightweight communication can be gained without creating a distracting burden for users. How can the industry meet the demand for robust platforms and standards for IM without locking out innovation and development?

In this discussion, we want to demonstrate how research prototypes that explore future directions can be used to guide and inform current efforts to develop an infrastructure. Our experience in using and studying IM has identified future opportunities in what we will refer to as "awareness services." That is, beyond the instant text-chat capability and sense of presence among online colleagues that IM provides, what other cues of activity should collaborators share to help coordinate their work? When a person you want to contact is not present, what information can the system provide to help you coordinate contact in the future? Even when you are physically present, can the system provide cues for when you are

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mentally receptive, or "available," to being interrupted?

As examples of potential solutions to these issues, we summarize three research prototypes that demonstrate future directions in awareness services:

- **Awarenex.** An IM and awareness prototype that demonstrates additional realtime awareness information useful both for initiating contact and negotiating conversation.
- **Rhythm Awareness.** A system that analyzes awareness information over time to predict future times to contact people who are not currently available.
- **Lilsys.** A system that integrates awareness information from a number of different sensors to infer when colleagues may not be available for interaction.

These three prototypes, along with other research in this area,[2, 3] demonstrate concepts that go beyond IM to a broader set of awareness features and services useful for coordinating group work online. Reflecting on the technical implications of our research prototypes informs the evolution of the platforms and standards being developed to support IM today, so they can anticipate (or at least not become an obstacle for) future directions in awareness services.

AWARENEX: REALTIME AWARENESS FOR INITIATING AND NEGOTIATING CONVERSATION

A major focus of the Awarenex design was tailoring the interface for using IM in the work environment.[4] While the same need to contact remote people that made IM popular at home was also useful in the work environment, what aspects of the work environment affected the design of IM functionality? The work environment suggested, for example, integrating other resources such as an online calendar and phone. There were also concerns about the potential distraction of using IM at work.

The interface for Awarenex offered two novel approaches to designing an IM service driven by this work-environment context:

- Integrating realtime awareness information to help provide cues about finding opportune times to initiate contact.
- Sharing realtime cues to help people negotiate starting, maintaining, and ending IM chats.

Exploring these interface features led to a design that contrasts with most commercial IM systems by identifying technical requirements for integrating new sources of awareness information and sharing it in realtime to support the coordination of distributed collaborators.

Figure 1 illustrates the ways Awarenex integrates other realtime awareness information to help users find good times to establish contact. For each entry in the Contact List, Awarenex shows not only the user's name, but also their "locale"—an indication of whether they are in their office, at home, or another location. A locale usually corresponds to a physical location, but it is more intended to convey a high-level description of the person's context rather than their precise physical location. For example, the "mobile" locale covers many physical locations and lets others know when the person is "on the road." This is an example of how an awareness system can balance the desire to know a remote person's context against the concern that precise location information may be too revealing. As systems become more location-aware, they need to support notions of location that range from physical coordinates to conceptual description.

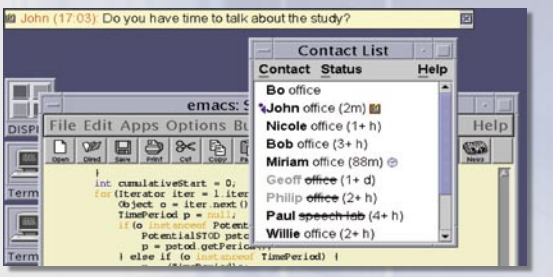
An indication of the user's absence is reflected by displaying any inactive duration of the user's keyboard or other input device (displayed in parentheses in figure 1). Beyond this presence information, such additional activity indicators as whether the user has an

FIG 1

Awarenex Contact List showing activity indicators

FIG 2

Contact preview showing an approaching IM request



appointment scheduled in their online calendar or is engaged in an IM or telephone call are included. Taken together, these indicators give cues about whether the user is preoccupied with some other activity, and thus is less receptive to additional incoming communication. Our experience with the value of adding awareness indicators in Awarenex suggests the need for an extensible framework that affords adding new sources of awareness information as they become available. To provide the flexibility for growth, the entire system—including the protocol, notification servers, and clients—needs to have the ability to accept, propagate, and display forms of awareness information that may not have been known when the system was designed.

If the Awarenex Contact List suggests that now is a good time to interact, Awarenex provides further realtime awareness cues to help negotiate the conversational process. These cues illustrate the wide range of awareness information that an IM infrastructure needs to support information sharing in realtime. Awarenex provides an IM recipient with a sense of an approaching interaction by presenting a small "Contact Preview" when someone initiates an IM (see figure 2). This contrasts with how most commercial IMs pop up a window when someone initiates an IM. The Contact Preview is a one-line panel that scrolls down from the top of the screen, showing the first line of input being typed into the IM window. This panel, along with an audio alert, provides a subtle sense of approach and an indicator of the incoming IM's topic (somewhat like the subject header in e-mail). The recipient must acknowledge the incoming IM by clicking in the Contact Preview before the IM window opens up.

On the sender's side, the background for an IM window is shaded gray until the recipient acknowledges the Contact Preview. This cue helps participants know when they are mutually engaged in an IM conversation. This indicator of mutual attention addresses a syndrome found in many commercial systems where the first exchanges of conversation are often used to confirm whether the person is really "there" and attending to the IM.

Figure 3 illustrates how Awarenex transmits text input character-by-character to support a sense of conversational flow in IM. This approach is in contrast to most commercial IM systems that buffer the text until the user sends the message (usually by selecting either *Return* or *Enter*). Seeing the other person's typing appear character-by-character not only provides a cue of whether that person is in the process of replying (instead of attending to other things), it also affords the possibility of anticipating what is being said before the typing is completed. While buffered messaging is closer to realtime than e-mail, character-by-character messaging even more closely models the synchronicity of face-to-face and voice

FIG 3

IM window displays character-by-character and leave-taking dots

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communication. Because the reader can anticipate what the writer is going to say, they can begin forming their response sooner, resulting in more efficient communication exchanges.

Figure 3 also illustrates the leave-taking interface designed in Awarenex. In contrast to most commercial IM systems, which close the windows as soon as a user ends the IM, Awarenex has a "Goodbye" button that initiates the leave-taking interface. Pressing "Goodbye" prints a system-generated message into the chat ("John waves goodbye") and starts a series of diminishing dots. This indicates an intent to end the IM, but leaves the IM connection open to provide some time (10 seconds) to negotiate any last-minute exchanges. Just as people in face-to-face conversation foreshadow when they are ready to leave by closing their notebook, stowing their pens, and packing up other props they have used in the conversation, Awarenex indicates this intent while still allowing time to gracefully negotiate ending the conversation. If no further conversation happens before the 10 seconds expire, the IM windows will close, thus ending the conversation.

These Awarenex features suggest other kinds of information beyond passing text among IM clients that need to be distributed by an IM infrastructure. Through the Contact Preview background indicator for mutual engagement in an IM, character-by-character text transmission, and the leave-taking interface, Awarenex demonstrates the value of sharing cues that people can use to negotiate starting, maintaining and ending IM conversations. Whereas the proposed standards currently under consideration treat text messaging and awareness information as separate components, Awarenex demonstrates the need to embed some forms of awareness information into text-based conversations. Furthermore, future standards for text messaging should accommodate the character-by-character flow of text, as demonstrated in Awarenex (and UNIX talk before it), to allow users to engage in more natural, synchronous communications.

RHYTHM AWARENESS: ANALYZING AWARENESS INFORMATION OVER TIME TO INFER PATTERNS

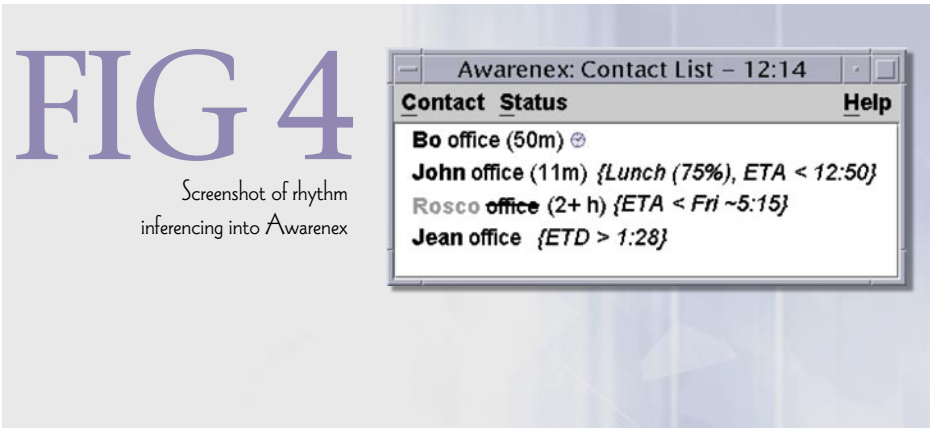
Awarenex and other IM and presence systems provide information about whether people are reachable for communication. But what if those individuals that you would like to contact are not reachable? Should you wait briefly to see if they will return, find someone else, or send a voicemail or e-mail message? When will they likely receive such messages?

Studying how colocated people handle the similar situation when a person is "away," researchers found that coworkers maintain a sense of each other's temporal patterns, or "rhythms," of presence.[5] This kind of awareness is useful for coordinating good times to attempt contact or plan meeting times. Remote collaborators, however, have difficulty forming and maintaining such "rhythm awareness" because they are not aware of each other's comings and goings over time.

In our own research group, which was split between sites that were separated by 2,500 miles and three time zones, we found this was partially alleviated with the use of Awarenex. Over time, we noticed that Awarenex not only provided an immediate sense of who is reachable for contact, but also gave a sense of long-term temporal patterns during the workday. For example, we became attuned to when our remote colleagues arrived and departed for the day, and when they left and returned from lunch. In our Rhythm Awareness research,[6] we explored how analyzing awareness information over time could be used to infer rhythmic patterns that would be useful in coordinating distributed group work.

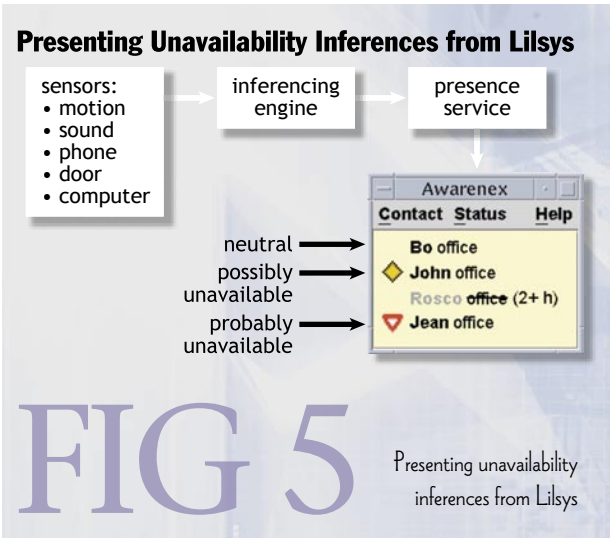
The Rhythm Awareness project models an individual's historic patterns of presence and uses the model to predict when someone will likely return from recurring periods of absence (e.g., morning arrival, lunch, weekly meetings).[7] It can also be used to forecast imminent departure so that remote coworkers can catch each other before they leave.

As an example of how rhythms can be used to facilitate communication, figure 4 shows a screenshot of the integration of rhythm inferencing in an Awarenex Contact List. In this example, the current time is 12:14 on a Thursday in the U.S. Pacific time zone. The first entry indicates that Bo has been inactive for 50 minutes, which does not correspond to a rhythmic pattern, so no prediction is made. The system infers that John is at lunch (75 percent probability) and predicts he will return on or before 12:50 (ETA, or estimated time of arrival). Rosco, an East Coast worker, is logged out, probably gone for



the day, and the system predicts he will return on Friday morning around 5:15 (8:15 EST). The entry for Jean, who also works in the eastern standard time zone, is different in that she is currently active but is approaching the end of her day. The system indicates that if others want to reach her before she leaves they should do so before 1:28 (ETD, or estimated time of departure). Placing these predictions in an IM Contact List provides prospective callers with information they need before attempting to contact someone. Thus, callers can decide whether to attempt to reach a different person or leave an asynchronous message for a currently unreachable recipient.

The Rhythm Awareness research demonstrates a new kind of awareness information that calls for infrastructure support in the capture and analysis of temporal aspects of awareness information over time. Recording and analyzing data increases a system's storage and processing requirements beyond merely propagating awareness information.



LILSYS: INTEGRATING SENSOR INFORMATION TO INFER UNAVAILABILITY

A concern raised by real-time presence and awareness information is that it could subject people to even more interruption as more people are aware of when others are online. The fact that you are physically reachable does not necessarily mean you are mentally receptive to being interrupted. In fact, the computer activity that indicates your presence may occur when you are most busy and least receptive to an interruption. The conventional way of avoiding unwanted interruptions is to explicitly let others know when you are not "available" by setting your status to "away" or "busy." This approach often fails, however, because it requires direct action that few people take—especially when they are busy.

Another way to manage availability is to have the system gather clues from your environment and present an inference about your availability. Researchers at Carnegie Mellon University conducted a study to determine the most salient sensors in making an availability inference of an office worker.[8] Based on their results, our research group prototyped the Lilsys system, which consists of the most salient sensors identified: sound, phone usage, and computer activity. In addition, Lilsys includes a motion sensor to detect a person's presence, a necessary condition for inferring availability. We also added a sensor to detect when the door is open or closed for staff who close their door when they do not want to be disturbed.

Lilsys synthesizes information collected from the sensors and attempts to infer when the person is not available for an interruption. Figure 5 illustrates the information flow as sensor data are fed to an inferencing engine, which posts the inference to a presence service, which in turn propagates the inference to clients. The inferencing engine makes an assessment of the person's unavailability based on the amount and type of evidence collected by the sensors. To suggest a person's inferred unavailability to a prospective caller, Lilsys uses a traffic-sign metaphor: neutral (no inference), a diamond-shaped yellow "warning" sign that indicates possibly unavailable, and a triangular, red-bordered "yield" sign to indicate the person is probably unavailable.

Availability inferencing can coexist with setting

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explicit status in a presence system because they have complementary tradeoffs. Whereas setting status explicitly requires user action, the sensors collect information passively. Also, explicit status is obtained only when the user remembers to set it, while the availability inference is updated as soon as a change in the user's context is sensed. On the other hand, while an availability inference is necessarily vague, explicit status can be descriptive. Rather than presenting all of the details about a person's context, Lilsys presents an abstraction of the person's

A Closer Look at Our Common Wisdom

ELLEN ISAACS, FREELANCE INTERACTION DESIGNER AND RESEARCHER

Most current impressions of how Instant Messaging (IM) is used in the workplace stem from anecdotal reports obtained through interview studies or marketing surveys. Although these can help people gain a sense of prevailing practices, such studies are typically based on only a small set of users and are devoid of data derived from direct observations. While at AT&T Labs, four colleagues and I had the opportunity to study a very large sample of monitored IM interactions—over 21,000 IM conversations involving 437 users conducted from mid-2000 to late 2001. Alan Walendowski, Steve Whittaker, Diane J. Schiano, Candace Kamm, and I analyzed the IM conversations we collected and were interested to discover that some of the most popular notions about the character, functions, and styles of IM in the workplace are mistaken. For example, contrary to prior research, we found that workplace IM is primarily used for complex, work-specific interactions, with only a portion used for the type of "quick question" or coordination activities most often mentioned in the literature. Only 28 percent of the conversations we monitored proved to be simple, single-purpose interactions, and only 31 percent focused chiefly on scheduling or coordination matters. Moreover, we found that people rarely switched from IM to a different conversation medium once discussions grew complex, as is frequently suggested in reports of IM usage. These findings, along with some others discussed next, suggest certain design considerations for applications developers.

We found evidence of two styles of use, only one of which is currently widely acknowledged. In the interactions we monitored involving people who either infrequently use IM or rarely communicate with each other, we discovered that messages tended to focus chiefly on scheduling and coordination matters and that the conversations were slow paced and involved little threading or multitasking. Frequent IM users, on the other hand, tended to use IM more as a tool for collaboration, with discussions covering a broad range of topics via many fast-paced interactions—each with many short turns in the conversation, much threading, and a predisposition towards multitasking. Although people consistent with our "light user" profile have until now been generally regarded as typical of all IM users, our research suggests that the majority of IM traffic actually involves heavy users working collaboratively to address complex, work-specific problems.

Our study examined IM conversations logged on a prototype instant messenger application called Hubbub, which is similar to other IM products in that it includes a "buddy list" feature that enables awareness of—and ready access to—other potential conversation partners. Also, like other IM products, Hubbub supports near-synchronous, text-based interactions between participants.

Altogether, we captured 303,648 messages comprising 21,213 conversations between 692 pairs of users over the course of 16 months. From these conversations, we applied a variety of quantitative measures to learn more about their characteristics. First, we distinguished between heavy users and light users. Those who averaged three or more IM conversations a day were considered heavy users and the rest were considered light users. We also tracked these people's conversational partners, again distinguishing between heavy and light users. Then we conducted a content analysis on a smaller sample of the data (500 conversations among 28 users) so that we could categorize the character of the conversations. When we analyzed what people were using instant messages to accomplish, we discovered several interesting

unavailability, which provides a measure of privacy by hiding the details of a person's activity. Individuals have differing tolerances for privacy/publicity trade-offs.

Awareness systems need to help users understand the tension between their desires for privacy and availability to others, and they should allow users to control the extent to which they wish to present full details about their context versus an abstract inference of their availability.

Because Lilsys integrates information from a variety of sensors and other sources, it demonstrates yet another type of awareness service with implications for the architecture of platform infrastructures. In this case, the raw information from each source is potentially sensitive and not necessarily salient to users, while the resulting inference is salient. This suggests that a presence/awareness infrastructure should not necessarily propagate all forms of information to clients—some data should be routed only to trusted services that synthesize the data and inject an inference back into the infrastructure for propagation to clients.

findings, namely:

- Although a common impression of IM is that it's used primarily for simple questions and quick clarifications, we found that was true only about 28 percent of the time.
- Despite the perception that IM is commonly used for social purposes in the workplace, we found that was rarely the case. Only 13 percent of the conversations we monitored included any personal topics whatsoever, and only 6.4 percent were exclusively personal.
- Concerns that IM might distract people from their work proved to be unfounded. The majority of the workplace IM conversations we observed, 62 percent, focused entirely on work-related matters.
- Independent of function, we discovered that 23.6 percent of our study group's "conversations" consisted of one person sending one or more messages without getting a response within five minutes. Although this represents a sizeable percentage of the conversations, it's low in comparison to estimates of unanswered phone calls (62 percent) and failed attempts to start impromptu desktop video conferences (75 percent).
- Many articles in the popular media and in journals mention that people frequently switch from IM to another form of communication, such as phone or face-to-face, particularly when conversations become complex. We found that media switching was not common, occurring only 16 percent of the time, and they almost never (3 percent) happened because the conversation became too difficult to conduct via text.
- Not all of our findings contradicted popular notions of IM use. For example, IM conversations are thought to be quick, and indeed the conversations we monitored lasted about 4.5 minutes. That is also consistent with many other types of impromptu communications (whether face-to-face, over the phone, or by way of desktop video conferencing). Also, IM users are commonly reported to switch frequently between IM conversations and other desktop activities, and we found that to be the case. In 85 percent of the conversations, at least one user multitasked during the IM interaction. But perhaps surprisingly, only 23 percent of users carried on multiple simultaneous IM sessions—and only infrequently at that.

One design implication that might be derived from these findings is that although integrating voice or video with IM may serve to simplify media switching, people might make less use of this feature than expected. Our study suggests that some people seem to be very effective at discussing complex work topics using nothing more than text. And since all users often multitask while engaged in IM conversations, it would be a mistake to tightly integrate IM with certain applications, thereby making it difficult for users to jump from one application to another.

Our results also suggest that the characteristics of heavy IM use—multiple, brief, intermittent interactions throughout the day whereby the lines of communication are more or less left open for spontaneous conversation—mirror the nature of impromptu pair-wise interactions in other media. This finding suggests that other tools intended to supplement or work with IM should seek to support the characteristics of the sort of lightweight, unplanned interactions we witness each day in the places we work.

ELLEN ISAACS is a freelance interaction designer and researcher, focusing on the design and use of tools for communication and collaboration. Before going out on her own, she worked at AT&T Labs, Sun Microsystems, and several defunct start-ups. She coauthored an interaction design book, *Designing from Both Sides of the Screen* (New Riders, 2001) with Alan Walendowski. Isaacs is currently working on projects that are related to the capture, management, and sharing of photographs and videos.

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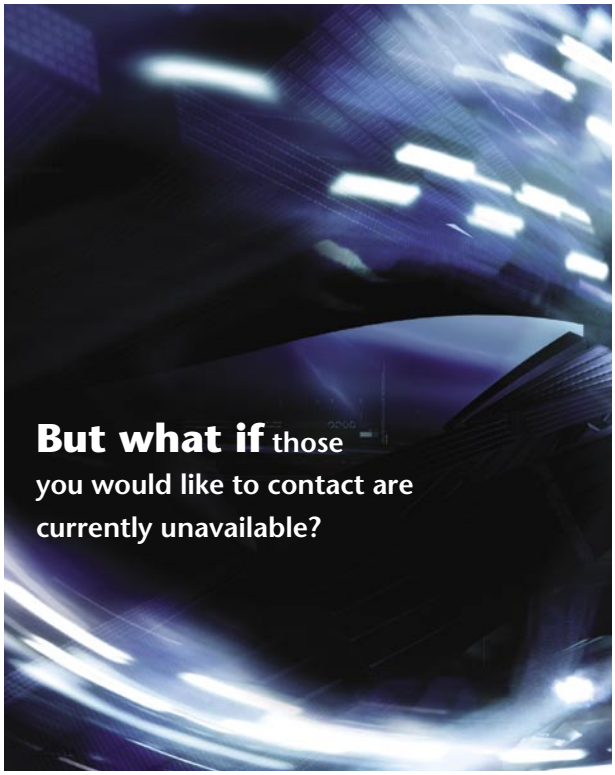
BEYOND "PRESENCE": TECHNICAL IMPLICATIONS FOR AWARENESS INFRASTRUCTURES

Presence is a unique and compelling feature of IM systems today, but it currently indicates only whether a person is reachable at the moment. Effective communication requires richer awareness information of current and future reachability, context, and availability. The three research prototypes presented here serve as examples of the kind of collection, analysis, and sharing of awareness information that infrastructures for future communication tools need to be capable of supporting.

For example, in addition to simple online presence, Awarenex demonstrates integration with other realtime sources of information, such as whether the user has a currently scheduled appointment in their online calendar or is engaged in a phone call. In addition, Awarenex illustrates that IM should be seen not as a communication channel in isolation, but as part of a spectrum of computer-mediated communication that includes e-mail, telephony, voice over Internet Protocol (VoIP), desktop videoconferencing, application sharing, calendar, and more. Thus, communication media need to have interfaces that integrate with each other to provide users with an experience that allows them to pick the right media for their needs. Research has shown that conversations that start in IM often migrate to another medium (e.g., phone, visit).[9] Communication media architecture should allow for easy and dynamic transitions among themselves to support this practice.



Awarenex also illustrates various approaches to supporting conversational mechanics, such as character-by-character transmission of text and a negotiated leave-taking sequence that helps participants gracefully end their conversations. This support of conversational mechanics emphasizes the use of instant messaging as a nearly synchronous form of communication, providing features closer to a face-to-face conversation than to mail. However, proposed standards under the Internet Engineering Task Force (IETF) working group's Instant Messaging and Presence Protocol (IMPP) encourage a nearly asynchronous mode of communication, losing the awareness of conversational engagement and the ability to anticipate conversation utterances. For example, although the Extensible Messaging and Presence Protocol (XMPP) does not preclude sending a message one character at a time, the header and XML formatting of the message would dwarf the one-character content. Platforms need to allow the use of a text-oriented streaming protocol—similar to those for audio and video streaming—for enriched, synchronous text messaging.

Another important concern is the privacy and security of awareness information. The very utility of awareness information in helping colleagues coordinate their activities also makes it important to maintain control over who has access to that information. Trusted associates, such as close colleagues and family, may have access to more information than those who are unknown to you. Developing mechanisms for giving the user control over who can see awareness information and how to negotiate sharing that information with others needs to be part of the development of any products that share awareness information.

Rhythm Awareness demonstrates that analyzing records of awareness information over time

can provide useful functionality in predicting a person's future state. Lilsys further demonstrates the realtime analysis of multiple points of context data to infer when a person is less available for an interruption. Taken together, they illustrate that, in addition to scaling to large numbers of connections, awareness services need to consider scalability of storage (for data collection) and processing (for data analysis). Furthermore, awareness services need to provide a means for adding new forms of awareness inferencing to the system as they are developed.

Platforms and standards designed to support IM and presence services of today should also anticipate developments in awareness information to support ongoing development. Client applications, too, must be able to display presence information not known when the clients were designed. Standards being proposed under the IMPP working group do include an extensible format for propagating presence information. We need to safeguard such extensibility from being diluted by incompletely implemented services that carry only de facto "standard" presence information. Furthermore, while these standardization efforts address the propagation of information among distributed components of the system, we also need to consider standardization of mechanisms that will allow clients to display new forms of awareness information when they are developed.

The popularity of IM has shown the utility of rudimentary presence information for facilitating communication. The research prototypes described here, along with other research in this area, suggest an emergence of promising awareness features that would further help distributed work groups communicate and coordinate their collaboration. Technical platforms and standards need to support the ongoing development of awareness features and be capable of including new awareness information and services as they emerge. The technical infrastructure also needs to address privacy concerns so that users can easily understand and trust their control over who has access to this information. By developing platforms and standards today that anticipate and accommodate future developments in awareness services, we can build communication tools that will gracefully support the emergence of new awareness services as they become available. Q

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JOHN C. TANG studies how people use technology to guide the design and development of new technology. His current research focus is designing new ways to support distributed work groups with a particular interest in awareness and IM. Prior to joining Sun Labs in 1990, Tang worked at Xerox PARC developing and studying several shared drawing prototype tools. His doctoral research at Stanford University studied the use of shared workspaces in group design activity.

JAMES "BO" BEGOLE joined Sun Labs in 1999 as researcher and developer of collaborative computing. Begole received a B.S. in 1992 in mathematics from Virginia Commonwealth University, and an M.S. and Ph.D. in 1998 in computer science from Virginia Tech. Prior to his studies, he served in the U.S. Army as an Arabic language interpreter, stationed in the United States, Panama, Egypt, and Greece. Begole's research motivation is to explore applications of technology to do things not otherwise possible, primarily in the realm of distributed collaboration.