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Characterizing Communication in a Large-Scale, Global Deployment of a Broadcast Messaging System

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ABSTRACT

It has proved difficult to replicate in an online setting the various communication styles people are accustomed to in physical settings. One such style is informal communication, characterized by brief, unplanned and frequent communications. Broadcast messaging attempts to support informal communication online, by letting users send instant messages to largely anonymous groups of people, and initiate a real-time chat with those who respond. In studying a major deployment of a broadcast messaging system, we discovered a fundamental trade-off between a sender's ability to reach a large audience, and the tolerance of individuals in that audience for receiving many messages. We discuss the types of communications for which broadcast messaging has been used, and we evaluate the effectiveness of two specific techniques designed to prevent individual users being overloaded by broadcasts.

Author Keywords

Broadcast messaging, informal communication, filtering, spam

ACM Classification Keywords

H.5.3 Group and Organization Interfaces

INTRODUCTION

Informal communication, as characterized by brief, unplanned and frequent communications between physically present individuals [5], is important for performing 'knowledge-work' because it enables the execution of work-related tasks, team coordination, transmission of office culture, and social aspects of office life [14]. There have been many efforts to support informal communication using online communication tools, in order to bring the benefits of informal communication to workers who are not co-located. These started with video-based efforts such as the VideoWindow system [4], and EuroPARC's RAVE system [7]. These efforts have proved less effective than hoped [6, 11, 20]. More recently, both synchronous and asynchronous text-based tools have proven more successful at supporting informal communication, such as [2, 3, 10, 16, 19]. For example, studies of instant messaging in the workplace show that it can support several of the same kinds of activities supported by informal communication, such as maintaining social and personal connections, getting a quick answer to a question, coordinating and scheduling, maintaining family and work life, and supporting ongoing project-focused collaborations.

Broadcast messaging is the latest attempt to support informal communication online [12, 13, 18]. Broadcast messaging is similar to instant messaging, as messages are sent out, received and responded to in real-time. However, broadcast messages are sent to an audience whose members may or may not be known in advance to the message sender.

In this paper, we study the use of a broadcast messaging system deployed throughout IBM worldwide, called IBM Community Tools, and we offer an analysis of how this tool supports informal communication. While previous studies have explored the utility of broadcast messaging for a small scale deployment [12, 18], we believe that there are no studies that have investigated its use on an enterprise scale. Studying broadcast messaging at this scale is interesting because it is precisely in a large, geographically dispersed organization where online support for informal communication is most needed.

One downside to broadcast messaging is the potential for abuse. Message senders benefit from the ability to reach large numbers of recipients, but they also have the power to distract, disturb and overload those recipients. Our study looked at this issue for ICT. We analyze the trade-off between the usefulness of broadcast messaging and overloading message recipients, and evaluate the effectiveness of two specific techniques implemented within ICT designed to address this trade-off.

IBM COMMUNITY TOOLS

The IBM Community Tools (ICT) are a set of messaging services designed to support informal communications among IBM employees. Their primary function is to allow IBM employees to send broadcast messages to other users of ICT, and receive a response back in real-time, by way of instant messaging. ICT was deployed internally at IBM in March 2002, and as of this writing, has been used by over 35,000 people throughout IBM worldwide.

Figure 1. An example FreeJam window. Alert windows for SkillTaps, PollCasts and w3alerts are almost identical.

The ICT suite consists of eight utilities which allow IBM employees to communicate and collaborate with one another instantaneously. Included in ICT are a SameTime instant messaging client, which provides instant messaging services among IBM employees; a BluePages application which allows employees to look each other up in the master IBM address book; and Question Search, a program which lets users access a database of knowledge compiled by IBM employees. However, the core of the ICT toolkit is composed of tools used for sending broadcast messages:

- **FreeJam** creates a group chat session with all of the responders.
- **SkillTap** establishes a direct SameTime connection between the sender and the responder, allowing for a one-on-one discussion. SkillTap is also linked to Question Search, such that the responses provided to a SkillTap question can be added to the Question Search database.
- **TeamRing** is used for groups who want to view a web site simultaneously. It is typically used for giving presentations over the web. Since the TeamRing tool is used only by groups which have a pre-existing relationship outside of ICT, we exclude it from our discussion and analysis.
- **PollCast** is used to conduct a live poll, the results of which are compiled in real time.
- **w3alert** is used for broadcast messages which do not need a reply, and it is typically used for automated alerts and notifications. A URL can be sent along with the message, allowing users to share links with one another.

When a broadcast message is received, it is displayed to the user in the form of a sliding window in the bottom-right corner of their screen. The position and duration of the alert can be changed by the user, and the user can also configure an audible alert when a broadcast is received. An example alert for a FreeJam is shown in Figure 1.

Subdividing the Messaging Space

Because broadcast messages have the potential to reach thousands of people, some care needs to be taken in targeting these messages to an appropriate subset of people. We

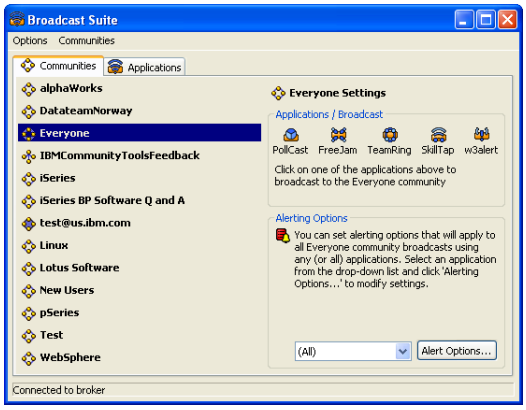

Figure 2. Before a user sends a broadcast message, they must first choose the community to which it will be sent. The user interface for choosing a community is shown above. This screenshot is taken from a public ICT deployment, and so the community list differs from that of the internal IBM deployment we studied.

define a *relevant set* of people for a given broadcast message as a set of people who are either passively or actively interested in that message, or its content. Thus, a user who either responds to a message, or merely scans its content for interesting information, is considered a relevant user for that message.

Given this definition of relevant sets of users, it is imperative to the success of a broadcast messaging system to provide a means for targeting a broadcast message to a relevant set of users; otherwise, the entire populace risks being exposed to every broadcast message sent.

ICT implements two main features for reaching a relevant set of users: senders are required to direct their messages to a chosen "community", and receivers are given filtering tools to either allow or deny messages upon receipt, based on specified criteria.

Communities

The primary way that ICT users target their broadcast messages to a relevant set of users is through the use of "communities". These communities are not necessarily communities in the traditional sense [1, 17], although they may satisfy some of those criteria, such as a shared purpose, or policies, rituals or protocols which guide people's interactions.

There are three types of communities in ICT: public, private and moderated. Both public and moderated communities are open to all ICT users. Private community membership is limited to users who are invited by the community's owner. Signing up for a community enables a user to send broadcast messages to that community (unless it is moderated), and receive broadcast messages from other members in that community. Currently, users can not broadcast messages to communities to which they are not subscribed.

Figure 2 shows the ICT screen where users select the community to which they want to send their message. This screenshot is taken from a public ICT deployment, so the community list differs from that of the internal IBM deployment we studied.

There is one special community in ICT called 'everyone', to which every new ICT user is subscribed by default[1]. Thus, this community makes it possible to send a message to almost every ICT user. Since it is possible to unsubscribe from the 'everyone' community, this community is not truly composed of 'everyone' using ICT.

Client-side Filtering

The ICT client provides several mechanisms for allowing users to filter broadcast messages when they are received. This client-side filtering process involves receiving a broadcast message in the ICT client, matching it against the user's filtering policy, and then displaying or discarding the broadcast message. Users can use one of two types of filters, which can be set on both a per-community basis, as well as a per-application[2] basis:

- **Manual filtering** allows users to specify lists of keywords which should be used for both accepting and rejecting messages. For example, one keyword filtering rule might read "accept all messages containing the word 'pancake', and another might read "reject all messages containing both 'belgian' and 'waffle"'. Manual filtering also allows users to specify regular expressions as filtering rules.

- **Adaptive filtering** uses a machine learning algorithm to learn a user's preferences in message content over time. When adaptive filtering is turned on, the user is given two additional options when a broadcast is received: "Discard messages like this one", and "Show me more messages like this one".

Filtering allows users to manage the messages which are displayed to them, while still allowing them to participate in the communities in which they are interested.

DATA COLLECTION

In order to understand how ICT was being used, for what purposes it was being used, how much it was being used, and who was using it, we collected data from several sources:

- **Broadcast messages sent to every public community.** We used a modified ICT client to log the timestamp of when a broadcast message was received, the community to which the message was sent, the sender of the message, and the contents of the message (known as the "topic"). Data were collected over a two month period, from June 14th to August 5th, 2004.

- **FreeJam participants.** Using our modified ICT client, we were able to automatically join every FreeJam and record the user IDs of everyone who joined.

- **Analysis of newsgroup posts.** We monitored messages posted to an internal IBM newsgroup about ICT.

- **Survey of ICT users.** We conducted an online survey of ICT users who had joined at least one FreeJam or sent at least one broadcast message during our logging period.

Caveats

For a variety of reasons, we were either unable to collect or consciously chose not to collect certain types of data.

- **We did not log the contents of FreeJam chats.** This was a conscious decision, and was made to preserve users' privacy.

- **We were unable to determine exact subscription counts for each community.** This is a limitation of the underlying broadcast messaging architecture, as it does not keep track of the number of subscribers to each community. Thus, we can only approximate this value by looking at how many users either join a FreeJam or send a broadcast message in each community.

- **We only logged data from public communities.** Since an invitation is required to join a private community, our analysis focuses only on public communities.

Although in an ideal world we would have liked to have collected and analyzed these additional sources of data, when studying a real-world deployment of a technology, such limitations are typical. From the data we have collected, we have been able to draw useful and significant conclusions about the use of ICT for informal communication.

RESULTS

In this section, we present selected results from our logged data set, and from our survey. The discussion section discusses the implications of these results in more detail.

Logged Data

During our logging period, we received 7,414 broadcast messages over all communities. The number of communities we logged varied between 842 and 894 during our study, as new communities were created during the course of logging. There were 8,921 unique users seen participating in ICT, either by sending a broadcast message or by joining a FreeJam.

	All	'everyone'
FreeJam	3,587	1,452 (40%)
SkillTap	1,857	655 (35%)
PollCast	534	91 (17%)
w3alert	1,436	1 (.07%)
Total	7,414	2,199 (30%)

Table 1. Breakdown of the numbers of each type of message sent to all communities, and to the 'everyone' community.

[1]This actually changed towards the end of our study in a new ICT release, so new users have to manually subscribe to 'everyone'. It is unclear whether this change will be reverted in the future.

[2]Application as in FreeJam, SkillTap, PollCast or w3alert.

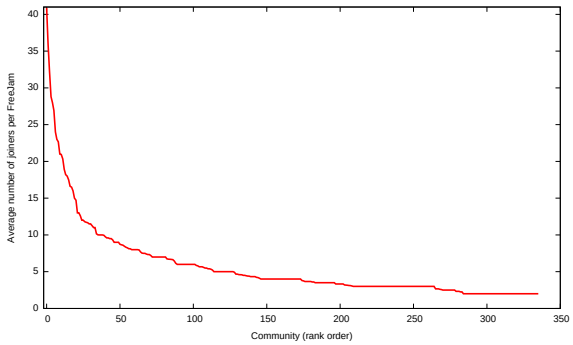

Figure 4. Distribution of the average number of joiners per FreeJam in each community, rank ordered. The 'grammar - punctuation - style' community had an average of 40.9 joiners per FreeJam, the highest of all communities. The 'everyone' community had an average of 26.92 joiners per FreeJam.

Of these, 2,113 sent at least one broadcast message. Table 1 gives a breakdown of the number of FreeJams, SkillTaps, PollCasts and w3alerts sent to all communities, and sent to the 'everyone' community.

In order to better understand the messaging activity occurring over all ICT communities, Figure 3 (left) shows the distribution of the number of broadcast messages sent to each community, rank ordered. Note that only 465 communities received one or more broadcast messages during the logging period. In this graph, the top 10 communities received 58% of the broadcast messages sent on ICT (4,330 of 7,414 messages).

Much of our detailed analysis focuses on FreeJam broadcasts. Figure 3 (right) shows that FreeJam messaging activity follows the same distribution across communities as messaging activity combined across all tools.

To determine the effectiveness of broadcast messaging in generating a response, a graph of the average number of joiners per FreeJam for each community is shown in Figure 4. Communities with an average number of joiners per FreeJam less than two are not shown.

Survey Data

From July 30th to August 6th 2004, we ran an online survey asking questions about the ICT user experience to a broad variety of ICT users. In order to have an appropriate representation of the many different types of ICT users, we identified five categories of users, and sent a link to our survey to a random selection of users matching each category. These categories were: people who had sent a message to the 'everyone' community in the week prior to the survey (25 people); people who had joined an above-average number of FreeJams (25); people who had sent an above-average number of broadcast messages (25); people who had joined a below-average number of FreeJams (25); and finally, people who had sent a direct SameTime message to the primary author of this paper, asking why he was joining every FreeJam (4).

Satisfaction

	Most			Least	N/A
FreeJam:	20	26	6	0	21
SkillTap:	13	25	5	1	26
PollCast:	6	13	6	3	39

Table 2. Survey rankings showing respondents' satisfaction with the response received for each type of broadcast message, on a four point scale. Each cell in the table is a count of the number of respondents who belong to the corresponding category.

Since the survey results were kept anonymous, we do not know how many people from each group responded to the survey. Also, one of the survey takers posted a link to our survey on his internal IBM web log, thus implying that our recipient population may further be skewed.

Our survey received 75 responses. Of the respondents, four had used ICT for less than one month, ten had used ICT for between one and three months, 60 had used ICT for more than three months, and one did not answer this question. Based on our survey, we found that 54% of users were subscribed to 20 or less communities, and 46% were subscribed to more than 20 communities. Of those subscribed to less than 20 communities, the average number of subscriptions was 7.8.

The most commonly cited reason for sending broadcast messages was for asking a specific question (45 people ranked this as number 1). The second most common reason for sending broadcast messages was for finding a person with a certain expertise or experience (6 people ranked this as number 1, 24 ranked this as number 2).

Since the primary purpose of ICT is to receive information in some form, we asked respondents how satisfied they were with the responses they received when they sent out a FreeJam, SkillTap and PollCast. We separated out each message type because some users do not send messages of each type, and we wanted to see if there was a difference in satisfaction across message types. The results of this analysis are shown in Table 2. They show that for FreeJams, 63% of users reported that they were more satisfied than dissatisfied with the responses they received. For SkillTaps, 54% of users reported that they were more satisfied than dissatisfied with the responses they received. On the other hand, PollCast users were only slightly more satisfied than dissatisfied with the responses they received.

Broadcast Topic Analysis

In order to understand whether ICT is able to support a similar range of informal communication activities to those found in previous studies [12], and to discover what other activities it might support, we hand-coded roughly 50% of the 1,452 FreeJams sent to the 'everyone' community. Table 3 shows this analysis. We chose to code the messages

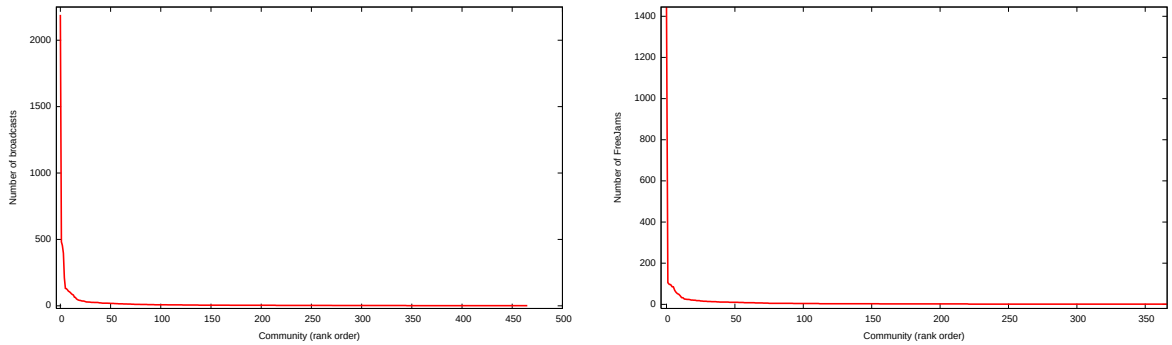

Figure 3. ***On the left:*** **Distribution of the number of broadcast messages received in each community, rank ordered. The 'everyone' community received 2,199 messages, the greatest number of all communities.** ***On the right:*** **Distribution of the number of FreeJams received in each community, rank ordered. The 'everyone' community received 1,452 FreeJams, the greatest number of all communities.**

Forms broadcasts take	**Topic of communication**						
	Technical	Organizational	Business	Social	Meta	Other	**Total:**
Announcements	8	1	0	1	0	0	10
Ask specific questions	294	36	8	5	30	0	373
Find a person with some characteristic	5	8	7	1	1	0	22
Initiate a discussion	31	1	1	2	0	0	35
Find an information resource	95	45	25	1	0	0	166
Find a person with prior experience	18	0	4	0	0	0	22
Find an expert	18	2	1	0	0	0	21
Find "how-to" material	54	5	0	0	1	0	60
Coordination	0	0	0	2	0	0	2
Network status	7	0	0	0	0	0	7
Other	0	1	2	1	3	2	9
Total:	530	99	48	13	35	2	727

Table 3. Classification of the types of broadcast messages sent to the 'everyone' community using the FreeJam tool. Finding an information resource includes finding online tutorials, URLs, software or papers. "How-to" material includes information on setting up or using a tool, or performing a procedure.

sent to 'everyone' because we felt they would be most representative of the types of messages being sent.

Three of the messages we coded were test messages from users who wanted to learn how ICT worked, so we discarded these from our analysis. The proportion of test messages in our sample was much smaller than the proportion reported by Jacovi [12] in their small-scale, local deployment of a broadcast messaging tool. Part of the reason for this is that ICT has been deployed for over two years, so the ratio of new users to veterans is low. Also, when a new user installs ICT, the system automatically creates a private community for the user, and then guides the user in sending a test message to themselves. In addition, there are several public communities whose sole purpose is to help users become acquainted with ICT, primarily by sending test broadcast messages.

DISCUSSION

Broadcast Topics

Analysis of the broadcast logs suggests that there are five topics covered in the broadcast messages: technical, business, organizational, social and meta, which relates to the use of ICT and broadcast messaging. None of these categories are especially surprising, given the number of people IBM employs with either a business or technical background. Many of the public communities we logged focused on specific technical topics, such as Unix, Java and WebSphere, and in these communities, the broadcast messages primarily focused on technical issues. Communities focused specifically on business issues were less common, suggesting either that ICT has not had the same level of use by business people, or that business people primarily use private communities. Based on [15], we speculate that ICT use is less mature amongst our business population.

Another common topic of the broadcast messages we coded focused on organizational processes and finding organizational information. There were also a small number of messages which contained comments and questions about ICT itself. These kinds of meta-conversations accounted for an even greater portion of the broadcast messages in Jacovi's study [12], possibly because a less mature deployment was studied.

Many of the broadcast messages logged during our study were of a social nature. These are not strongly evident from the analysis of the 'everyone' community, because such broadcast messages were typically sent to communities that were created specifically for socializing. Examples of social communities include 'UK Water Cooler', 'soccer' and 'IBM Computer Gamers'. These communities used broadcast messages to initiate chats about a particular topic, or sometimes about no topic at all. They also used the URL sharing feature of w3alert to point to interesting sites on the web. Perhaps the most illustrative example of this is with the 'soccer' community. During the World Cup 2004, members of this community broadcast status updates of the various matches, took polls to see what teams were popular, and sent URLs linking to interesting news stories about the matches. Social conversations are common in informal communication, and are an important characteristic of this style of communication. In an organization, social communications help maintain members' loyalty and goodwill [14], and can reduce feelings of isolation common in a large organization. Even just being able to see the activity of others can help people feel less isolated.

Patterns of Use

Based on our survey, the broadcast messages we logged, and the subset of messages we coded, we have identified a number of different patterns in which broadcast messages have been used, irrespective of the topics of those broadcast messages. We discuss several of the most interesting uses below.

Asking Specific Questions

ICT users can ask specific questions using either the FreeJam tool or the SkillTap tool, which was designed specifically for this purpose. In agreement with the findings of Jacovi et al. [12], the overwhelming majority of the coded FreeJam broadcast messages are specific questions, and 60% of people surveyed said their primary reason for using ICT was to have their questions answered. Because asking questions is such a popular use of a broadcast messaging tool, ICT has an additional feature to store the responses to SkillTap questions in a database, which can then be searched using the Question Search tool. 63% of respondents said that they actually searched this database before broadcasting a question. However, of these, only 42% reported that Question Search was useful at least some of the time.

Locating Resources and People

Although not a reason given by those surveyed, analysis of the broadcast messages to the 'everyone' community showed that looking for resources and people with non-expertise related characteristics[3] is a common use of ICT. Finding the location of resources such as URLs, online forms, tutorials, internal software and documentation represents almost 23% of the broadcast messages in our coded sample. This is not surprising, given the growth in the amount of organizational information online, and the difficulty of finding that information when it is needed.

[3]This can include finding a person with a particular job function, or finding a person who lives in a certain area.

This form of informal communication is also typical in face-to-face settings. People often ask co-located colleagues to recommend a tutorial, or to help find a particular kind of document. In fact, knowing where things are, or which resources are the best sources for a particular purpose, is the kind of knowledge that is vital for day-to-day work, but is not well encoded within existing online repositories.

Expertise Location

Expertise location is currently a popular topic for research. However, our results show that people are just as concerned with having their questions answered by anyone who has prior experience (21 broadcast messages), as with finding an expert (22 broadcast messages). This suggests that in general, senders trust that their audience will only respond if they have something valuable to contribute. Table 2 shows that people generally report a high level of satisfaction with the responses they receive, suggesting that regardless of expertise considerations, responders are generally responsible about providing appropriate and useful information.

Event Notification and Announcements

Broadcast messaging lends itself readily to event notification, such as announcing a new virus, or sending organizational alerts. Jacovi et al. [12] noted these kinds of broadcasts in their study. Sometimes, if an event repeatedly occurs with some frequency, event notifications can be automatically generated with that frequency, or in response to a trigger. For example, there are ICT communities used for monitoring posts to a newsgroup, and an automated piece of software automatically sends a w3alert whenever a new message is posted to that newsgroup.

The use of such a tool for this purpose is somewhat surprising, given that there is no way to tell how many people receive a broadcast. However, our analysis shows that broadcast messaging has been used in situations where the benefit of synchronicity for an urgent message, which requires immediate action, outweighs the importance of reaching all those who should be concerned with the announcement. Examples of this include warning users to not open an email containing a virus (as this message can also be repeated), or announcing the beginning of a seminar or lecture.

Team Coordination

We observed several communities where broadcast messages were used to coordinate teamwork and day-to-day activities. This kind of coordination is typical in informal face-to-face communication [5]. The clearest example of this in ICT was a team of workers in a call center. Throughout the day, the leaders of this team periodically broadcasted how many calls were in the queue, reminded call handlers to keep their call times low, and sent updates about specific problems encountered by many of the callers.

We have also found broadcast messages used for coordinating social activities in the workplace. For example, one community had automatic announcements for morning and afternoon coffee, which we speculate led to a mass of individuals gathering in the cafeteria to drink coffee together.

However, as this community was created for a different IBM location, we could not verify the effectiveness of these alerts.

Monitoring

Using a broadcast messaging system for awareness and monitoring has not been previously reported. 28% of those surveyed reported that ICT allows them to monitor what kinds of topics are of current interest within the organization. The importance of this monitoring behavior is further emphasized by several users who report that they join FreeJams just to see what is said. An awareness of the current important topics within an organization plays an important role in a person's productivity, and typically, this awareness is gained through informal communications [20]. Through ICT, users are able to monitor a far wider variety of topics than they could in a physical setting.

Helping

Our survey revealed that many ICT users are motivated not by the opportunity to send broadcast messages, but by the opportunity to respond and share knowledge with others. In fact, many of the users who frequently join FreeJams do not send many broadcast messages. Of the top 50 FreeJam joiners, 54% did not send any broadcast messages whatsoever. From our data, we cannot know whether those who joined a FreeJam actually made a significant contribution to the discussion, or resolved the senders question; however, Table 2 shows that people report a positive level of satisfaction with the answers they receive when using the FreeJam tool.

Temporal Patterns of Use

We have found that communities exhibit temporal patterns of activity, based on the rhythms of their members. For example, Figure 5 (left) shows a community with members primarily located in the United States[4]. This community becomes active around 7am, has a peak of activity during the early morning, has a steep decline in activity around lunchtime, reaches another peak during the mid-afternoon, and finally tapers off to no activity after 6pm.

Another pattern is for communities with members whose timezones have no overlap, shown in Figure 5 (center). In this case, the single community may actually function as two separate communities. From a person's perspective, some communities may appear to have no activity, when in fact all of their activity occurs after that person's work day has ended. Also, workers who use ICT outside of the regular workday may find themselves communicating regularly with people in different geographies, and hence become conduits of information that may not be available in their physical location.

Finally, a community may have participants from several different time zones. Figure 5 (right) shows a community used by workers in overlapping timezones, with sustained activity over an 18 hour period. It is unlikely, however, that the community members online at the start of this period are the same set as those that are online at the end of this activity period. We speculate that workers who are online during the central period of community activity act as information intermediaries between workers who are online during the starting and ending period of community activity.

Awareness of the temporal patterns of community activity can be an important tool for users who wish to take better advantage of the informal communication possibilities enabled by broadcast messaging. Depending on the urgency of a user's question, they may choose to wait until their target audience is most active.

Utility vs. Overload

As discussed in the introduction, there is a trade-off inherent in broadcast messaging between being able to send messages to a large audience, and overloading individual recipients with messages. In this section, we use the data we have collected about ICT usage to examine this trade-off in more detail. We seek to answer the following questions: Is the size of the audience an important consideration for users when they send broadcast messages? Are users overloaded by the messages they received? What techniques exist in the system for helping users manage overload? Are these techniques effective?

Members of the 'everyone' community are the most likely to suffer overload because, as shown in Figure 3, the 'everyone' community received a significantly greater number of broadcast messages than any other community. Anecdotal evidence from the ICT newsgroup suggested that people were frustrated by the overwhelming volume of messages sent to 'everyone', and felt that a great number of people were misusing the 'everyone' community. The results from our survey confirm that overload is a problem for some 'everyone' community members: 24% of those surveyed had unsubscribed from the 'everyone' community, most commonly citing overload as the cause for their withdrawal. Of the 58 respondents who were still subscribed to the 'everyone' community, 60% listed "message overload" as a reason why they disliked the 'everyone' community.

The frustration caused by large numbers of broadcast messages appears to have two separate causes. The first deals with the appropriateness of the message for the community to which it was sent. Our survey respondents reported feeling overloaded because most messages sent to the 'everyone' community were specific questions for which there already existed a more appropriate community. Of the 35 respondents who listed "message overload" as a reason why they disliked the 'everyone' community, 43% reported that they were overloaded by "inappropriate messages". Interestingly, people have very strong (and sometimes differing) beliefs as to what is 'appropriate' for the 'everyone' community. For example, in the ICT newsgroup, one ICT user said, "What question is possibly so important that ALL IBM employees need to be asked RIGHT NOW? I can't think of a single one." (emphasis in original). A second user said, "I think service up/down warnings and 'Pete's worldwide broadcast starts in 5 minutes' are examples of the limited type of thing I see as valid." Yet another said, "I cannot imagine a situation where I would fine it appropriate to send a question of

[4]All times referenced are in Eastern Daylight Time (GMT-4).

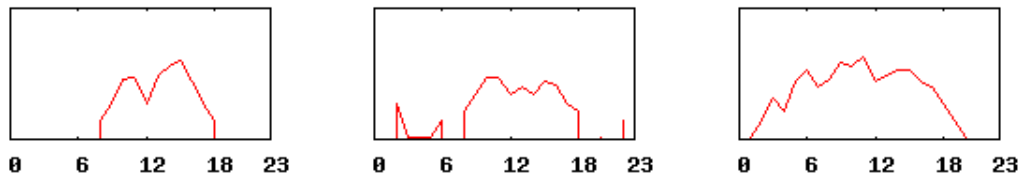

Figure 5. The above figures show the amount of messaging activity in a community over a 24 hour period. *On the left:* A community with members based in the United States. *In the middle:* A community with members in different, non-overlapping timezones around the world. *On the right:* A community with members spanning several timezones.

my own to every single ICT user in the company. I've tried to think of a reason anyone would want or need to do that, and I just can't."

A second reason why users are frustrated with the 'everyone' community has to do with the distraction caused by ICT's alerting mechanism. By default, whenever a broadcast is received, a small window slides in the corner of the screen, and obstructs the area of the screen which it covers for several seconds. Figure 1 shows an example FreeJam window. Of the 35 respondents who listed "message overload" as a reason they disliked the 'everyone' community, 43% reported feeling overloaded from "too many popups".

This suggests that recipient overload is a problem for large-scale broadcast messaging. However, in light of this, a considerable number of people remain subscribed to the 'everyone' community, and delight in their use of ICT. One common reason why people remained subscribed to 'everyone' is exactly the reason why broadcast messaging is so powerful: because they can reach a large audience. Of the 58 respondents who were still subscribed to the 'everyone' community, 43% listed "size of the potential audience" as a reason why they liked the 'everyone' community.

For some, receiving many messages has benefits. This is evident because an equally important reason people gave for liking the 'everyone' community was that it allowed them to monitor the topics other people were talking about, and offered them the opportunity to share their knowledge with others. Of the 58 respondents who were still subscribed to the 'everyone' community, 28% listed "the ability to monitor" as a reason why they liked the 'everyone' community, and 16% listed "the potential to respond" as a reason why they liked the 'everyone' community.

Some people have urged the ICT administrators to remove the 'everyone' community entirely. However, based on our analysis of participation in other communities (see Figure 3), we do not believe that there is enough activity in enough other communities to make people feel that these communities are adequately populated. As the ICT user interface presents no historical information regarding the number of messages sent to each community, nor does it present information regarding the number of users subscribed to each community, we believe that a significant bootstrapping problem would exist if a migration away from the 'everyone' community were attempted. Thus, we believe that the utility gained from having a community such as 'everyone' is greater than the burden it places on it's members from message overload. Furthermore, a community like 'everyone' may play a big role in attracting and keeping new users; it can ensure that there is always a critical mass of users sending broadcast messages, and that there is always a sufficiently large potential audience for messages sent, both of which are vital to the success of any collaborative technology [9].

The survey results show no relationship between the reasons given for liking and disliking the 'everyone' community. People who liked the 'everyone' community because it allowed them to monitor the broadcast messages were equally likely to list 'overload' or 'distraction' as a reason for disliking it. Thus, our results suggest that the trade-off between the utility from being able to reach a large audience, and the overload which can occur when many users exercise this power, is a real and important, and should be addressed by designers of broadcast messaging systems.

We now focus our discussion on two techniques implemented by ICT to manage recipient overload: the use of communities, and client-side filtering, and discuss their effectiveness.

Using Communities to Manage Overload

Our data is slightly contradictory with respect to how users perceive their use of ICT communities versus how they actually use them. Our survey results suggest that users do attempt to target their broadcast messages to a specific community. When sending a broadcast message, 55% of respondents said that their primary strategy for choosing a community is to choose from the list of communities to which they are already subscribed. Only 10% said that their primary strategy was to search the master list of all communities to find one appropriate for their message, although 30% said that this was their secondary strategy. Eleven respondents said their primary strategy was to simply send their message to 'everyone'. Our logging results shown in Figure 3 suggest that sending to the 'everyone' community is the approach of the majority of message senders. This contradiction could be due to a skew in our survey sample, or perhaps it suggests that what people say about their strategies reflects intentions, rather than actual behavior.

When asked about problems using ICT, several respondents noted that it is often difficult to find an appropriate community for their message. In addition, the interface for browsing communities does not provide a lot of help to users in finding an appropriate community. As shown in Figure 2, it consists of a single list which shows community names. Communities also have descriptions which explain what the community is about, although these are shown in a different part of the user interface. Often, the community names and/or descriptions are ambiguous. For example, there are many communities which seem appropriate places for sending broadcast messages about "WebSphere"; notably, 'websphere knowledge community', 'websphere tech ring', 'wsad', and others. We conjecture that because finding a relevant target community for a broadcast is non-trivial, users simply choose the 'everyone' community where they are assured of a large potential audience with a cross-section of expertise.

Using Filters to Manage Overload

Filtering is not used by the majority of ICT users. Only 18% of those surveyed currently use filtering and feel that it is effective. In general, most users do not understand the filtering model, and the user interface lacks appropriate feedback telling users what kinds of broadcast messages will be filtered. Respondents reported that they unsure of what kinds of broadcast messages to filter, and because of lack of feedback, they are not sure if the filters are working. They are also worried that if they use filters, they may miss a broadcast that is important to them. In general, people are more willing to put up with broadcast overload than miss an interesting broadcast message.

CONCLUSIONS

We have presented an analysis of the use of a broadcast messaging system in large, world-wide enterprise. Our analysis suggests that broadcast messaging can support many different types of informal communications. In particular, our study shows that broadcast messaging is used not only as a way to get urgent technical and organizational questions answered in a timely manner, but plays an important role in allowing employees to actively monitor and contribute to the flow of information and knowledge within the organization. Many people used the broadcast tool not only to send broadcast messages, but to see what broadcast messages were being sent by others, thus giving them the opportunity to share their knowledge with colleagues that they may never have had contact with otherwise.

We believe that a broadcast communications tool such as ICT can successfully facilitate informal communications in an organization. It does this by allowing people to opportunistically find people with whom to interact, outside of their existing physical and virtual communities. Although opportunistic, and not necessarily long-term, these ephemeral relationships are akin to the "weak ties" identified by Granovetter [8]. Similarly, they may play as important a role in the transmission of knowledge, information and social connections for online communities as "weak ties" do in physical communities.

There is, however, a trade-off inherent to any broadcast messaging system. Our results show that users are consciously aware that the opportunities to communicate with a large audience come at a cost of potentially being burdened with messages from others. However, for a majority of users, the potential benefits from being able to reach a large audience, monitor what others are talking about, and share knowledge with others, outweigh any overload the user may have to endure.

We examined the effectiveness of two techniques implemented in ICT for managing broadcast overload: communities, which divide up the recipient space into sets of relevant users for a broadcast, and client-side filtering, which allows recipients to either screen out broadcast messages containing topics not of personal interest, or bring to focus topics which are of interest. In our study, neither of these approaches were found to be effective. The ineffectiveness of communities is partially due to the lack of information about community activity levels, amounts of participation, and sizes of communities. The ineffectiveness of filtering is partially due to poor feedback mechanisms regarding what kinds of broadcast messages the filters will filter, users' beliefs that they may miss important or interesting information because of the filters, and users' uncertainty in what they should filter.

Thus, while ICT has been successful in capturing informal communications in an online setting, there are still challenges and opportunities available in managing recipient overload. Solutions to recipient overload must be sensitive to the inherent trade-off between the advantages and the disadvantages of a large potential broadcast audience.

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REFERENCES

1. A. L. Blanchard and M. L. Markus. The experienced "sense" of a virtual community: characteristics and processes. *SIGMIS Database*, 35(1):64–79, 2004.

2. E. F. Churchill, J. Trevor, S. Bly, L. Nelson, and D. Cubranic. Anchored conversations: chatting in the context of a document. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 454–461. ACM Press, 2000.

3. T. Erickson, C. Halverson, W. A. Kellogg, M. Laff, and T. Wolf. Social translucence: designing social infrastructures that make collective activity visible. *Commun. ACM*, 45(4):40–44, 2002.

4. R. S. Fish, R. E. Kraut, and B. L. Chalfonte. The videowindow system in informal communication. In *Proceedings of the 1990 ACM conference on Computer-supported cooperative work*, pages 1–11. ACM Press, 1990.

5. R. S. Fish, R. E. Kraut, R. W. Root, and R. E. Rice. Video as a technology for informal communication. *Commun. ACM*, 36(1):48–61, 1993.

6. S. R. Fussell, R. E. Kraut, and J. Siegel. Coordination of communication: effects of shared visual context on collaborative work. In *Proceedings of the 2000 ACM conference on Computer supported cooperative work*, pages 21–30. ACM Press, 2000.

7. W. Gaver, T. Moran, A. MacLean, L. Lövstrand, P. Dourish, K. Carter, and W. Buxton. Realizing a video environment: Europarc's rave system. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 27–35. ACM Press, 1992.

8. M. Granovetter. The strength of weak ties. *American Journal of Sociology*, 78(6):1360–1380, 1973.

9. J. Grudin. Why cscw applications fail: problems in the design and evaluation of organization of organizational interfaces. In *Proceedings of the 1988 ACM conference on Computer-supported cooperative work*, pages 85–93. ACM Press, 1988.

10. E. Isaacs, A. Walendowski, S. Whittaker, D. J. Schiano, and C. Kamm. The character, functions, and styles of instant messaging in the workplace. In *Proceedings of the 2002 ACM conference on Computer supported cooperative work*, pages 11–20. ACM Press, 2002.

11. E. A. Isaacs and J. C. Tang. What video can and can't do for collaboration: a case study. In *Proceedings of the first ACM international conference on Multimedia*, pages 199–206. ACM Press, 1993.

12. M. Jacovi, V. Soroka, and S. Ur. Why do we reachout?: functions of a semi-persistent peer support tool. In *Proceedings of the 2003 international ACM SIGGROUP conference on Supporting group work*, pages 161–169. ACM Press, 2003.

13. F. Jania. Broadcast messaging: Messaging to the masses. *Queue*, 1(8):38–43, 2003.

14. R. Kraut, R. Fish, R. Root, and B. Chalfonte. *Informal communication in organizations: form, function and technology*. Morgan Kaufmann, 1993.

15. M. J. Muller, M. E. Raven, S. Kogan, D. R. Millen, and K. Carey. Introducing chat into business organizations: toward an instant messaging maturity model. In *Proceedings of the 2003 international ACM SIGGROUP conference on Supporting group work*, pages 50–57. ACM Press, 2003.

16. B. A. Nardi, S. Whittaker, and E. Bradner. Interaction and outeraction: instant messaging in action. In *Proceedings of the 2000 ACM conference on Computer supported cooperative work*, pages 79–88. ACM Press, 2000.

17. J. Preece. *Online Communities: Designing Usability and Supporting Sociability*, chapter 1, pages 5–32. John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012, USA, 2000.

18. A. Ribak, M. Jacovi, and V. Soroka. "ask before you search": peer support and community building with reachout. In *Proceedings of the 2002 ACM conference on Computer supported cooperative work*, pages 126–135. ACM Press, 2002.

19. J. C. Tang, E. A. Isaacs, and M. Rua. Supporting distributed groups with a montage of lightweight interactions. In *Proceedings of the 1994 ACM conference on Computer supported cooperative work*, pages 23–34. ACM Press, 1994.

20. S. Whittaker, D. Frohlich, and O. Daly-Jones. Informal workplace communication: what is it like and how might we support it? In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 131–137. ACM Press, 1994.

Furthers the understanding of broadcast messaging systems in large-scale workplace deployments. Informs the design of new techniques for preventing users from being overloaded by large numbers of broadcast messages.