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Pervasive Messaging

Developing a new message architecture for the enterprise

Richard Stillman

ABSTRACT

The start of the 21st century finds most companies developing an increasingly mobile workforce. Distributed teams and telecommuting, among other trends, have made messaging a mission-critical application for most corporations. This trend shows every indication of accelerating. However, most companies still rely on independent, stovepiped systems for handling electronic, voice and paper messages. The awkwardness of dealing with several message pipelines is compounded by an absence of information that would allow a sender to determine the best way to reach his or her intended recipient.

Just in time, products are being developed to merge the traditional messaging technologies of voicemail, email, paging and fax. These systems promise to make workers far more productive by allowing them to send and receive messages, and manage their mail queues, more efficiently. None of these systems is a one-stop solution yet. However, almost all the pieces exist in current commercial products to create a complete messaging architecture that meets the following design goals:

- A unified, manageable interface for incoming messages, so the sender does not need to choose from multiple recipient mailboxes.
- Agent-mediated delivery of "new message" notification to the device of the recipient's choosing, including personal portable devices.
- Within the limits of the selected device, delivery of the message itself to the device of the recipient's choosing, including personal portable devices and the ability to split a message and send each part to a device appropriate to the content of that part.
- For the sender, information about whether an intended recipient is currently available to receive the message.
- The ability to send short messages with a fast enough delivery time to simulate conversation.

In brief, there is a need for a unified, multi-path system for messaging that completes the connection from sender to recipient, allowing each of them to use the tools they prefer. By integrating existing and developing products, companies can begin to meet this need today.

Acknowledgement

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R. Stillman

New technologies allow us to improve enterprise communications by unifying disparate messaging systems and extending them to wireless clients. We must develop rational architectures to incorporate these technologies into our business practices in a way that makes sense to both the companies and the individuals who use them.

INTRODUCTION

Collaborative work has always been most effective when members of a team are in close physical proximity. In a pioneering study, Tom Allen of MIT concluded that:

> *"People are not likely to collaborate more than once a week if they are located more than 50 feet apart."*

Each messaging method that has been introduced – voicemail, email, pager, fax, cell phone – has been an attempt to virtually extend this 50 foot radius. Each new method has extended the flexibility and capability of messaging, but the sum of these attempts has been confusion, not an integrated communication environment. This is true for two primary reasons:

- Messages are delivered to *an abstraction of the recipient* – most commonly a mailbox or screen. There is no reliable and timely way to guarantee the delivery of the message directly to the intended recipient. People sending messages have gotten used to the idea that leaving a message in a person's voice mailbox, sending them email, or sending a fax is the equivalent of contacting that person directly. In fact, it may be hours or days before these messages actually reach and are read by the people to whom they are addressed. (Note: The concept of a delivery guarantee should not be confused with a return receipt, which is after-the-fact notification and does not help a sender decide how to send the message.)
- Related to the abstraction problem is the unavailability of *presence information* to the sender of a message. Presence information allows a sender to know if the recipient of a message is available to receive the message immediately. Without that knowledge, the sender has no idea whether the intended recipient will pick up the message immediately, within the hour, or next week after returning from vacation. If the sender of a message does not receive a response, does that mean the recipient has decided not to answer? Is he or she still researching the problem, or has that person not even picked up the message yet? Lack of presence knowledge accounts for much of the effort wasted in sending multiple messages, via one or several media, to the same person. It also causes people to send the same query to multiple people, hoping that at least one of those people will be available to provide an answer.
- There is virtually no interoperability between messaging media. Voicemail, email and fax are almost entirely different worlds, with different delivery clients and protocols. Sending a message from one medium to another is difficult at best. Forwarding voicemail content – even between two compatible voicemail systems – is often impossible. As a result, individuals must check messages in several different media using the client specific to each (usually a telephone or PC), even in situations where another medium or client is vastly superior. For example, voicemail is far easier to check than email in an airport, but email is far easier to manage in a location where a PC can be set up and a network connection is practical.
- The lack of interoperability also isolates the advantages of each medium. Voicemail users cannot attach binary files to their messages, although this operation is simple in email. Email users must rely on complex client hardware – PCs and network or modem connections – to send and receive messages. They cannot use telephones, which are ubiquitous and cheap, to interact with their email.

Developments in the areas of wireless communication and universal messaging allow a consolidation of messaging systems that is based on good communications design rather than history and precedent. The products based on these developments can lead to a messaging architecture that

will move us closer to virtualizing Tom Allen's 50-foot radius of co-location.

Messaging Today: Equal but Separate

The current state of messaging is the result of the parallel, independent development of the major message delivery systems. Voicemail, email and fax developed at different times and with design goals and advantages different enough to allow each to grow without significant impact on the acceptance of the others. As a result, each developed its own culture and protocols. The significant differences in delivery clients, message richness and user interface meant there was a place for all three in virtually every business and each would develop its own adherents. In fact, many people prefer one system, assign greater importance to messages received in that system, and use the others only when forced. Until recently, products that attempted to merge these systems (fax-to-email servers, for example, or email vocalizers) addressed only a subset of the problem. The result in virtually every corporation has been a pipelined set of message systems with minimal interoperability.

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This architecture leads to uncertainty on the part of a sender: *I know who I want to send my message to, but how should I reach them?* The result is that people often send multiple messages, and the receipt of the messages themselves can be delayed or uncertain. Compounding the delivery problem is a second issue: *notification latency*.

Notification Latency

Email, voicemail and fax systems share a common flaw. As they are generally implemented, all require fixed infrastructure to notify a recipient of an incoming message. Voicemail notification is usually done through a "message waiting" light on the recipient's telephone. Email notification uses an audio or on-screen prompt on the recipient's PC. Fax machines generally make a sound when a fax is received, but this notification is of little use since most fax machines are shared and thus installed in common areas away from individual recipients.

In brief, all of these systems require that the recipient of a message be within physical proximity of a wired device in a fixed location to be notified that a message has arrived. If the recipient leaves that area, he or she must poll the mail system by calling to find out if messages are waiting. This change from *push* to *pull* delivery vastly decreases the efficiency of the messaging system and causes the effective separation between person and mailbox. It leads to one of the central problems of mail delivery: the significant difference between the concepts of sending to the *person* and sending to the person's *mailbox*.

All mobile workers deal with this difference whenever they are away from their PC or their own office telephone. People constantly take time to check their voicemail or email without a clue about whether they will find an empty mailbox or a full-blown crisis. A single fax number for a traveling worker is hardly better than paper mail as a delivery mechanism. But the problem goes beyond people traditionally considered mobile workers. *Anytime a worker leaves his or her office* – for a meeting, for lunch, to travel home, to attend an urgent meeting, or for any other reason – *that person becomes, for messaging purposes, a mobile worker*.

Paging – an inadequate solution

Some companies have adopted pagers, or the paging feature of digital cellular phones, as a partial solution to the problem of notification latency while on the move. Pagers are effective in notifying people of incoming messages. But paging services have several flaws that are mostly related to their poor integration into other messaging systems.

The first and biggest problem is on the back end: effective filtering. Voicemail systems

do not provide sufficient information for an agent to determine whether a message is important enough for pager notification. The second problem is lack of context – voicemail, again, cannot provide enough information in the actual page to allow the recipient to determine whether the call requires immediate response. Third is complexity. Email systems use programmed agents that are difficult to write and keep updated. Voicemail systems usually treat pager notification as an on-off feature that must be enabled by a system administrator – a very blunt instrument. The fourth problem is simple lack of integration – only some voicemail and email systems, and virtually no fax machines, support remote notification at all.

Problems Inherent in Current Messaging Architectures

Almost all workers have experienced some of the following scenarios:

- You're waiting for an important message but you've got to attend a meeting.
- You're on vacation but you spend a good deal of your time on the hotel phone, checking your voicemail for an important call.
- When traveling, you can check your email only in the morning and evening from your hotel room. You are unreachable for the entire business day because your client's firewall and analog dial-out policies prohibit you from connecting to your email system from your desk at the client's office. At best, you can dial in on a 56K analog line a few times a day, so your email responses are delayed for hours.
- When you travel, you lug your PC along only so you can deal with important email.
- Your email traffic approaches 100 messages a day, spread between various voicemail and email addresses.
- You spend a significant amount of time each day scanning your mailboxes, but you still find that messages sit in your mail queue for about an hour on average, and sometimes much longer.
- Somebody sends you a fax containing sensitive information, but it disappears from the fax machine before you pick it up.
- You find that you spend much of your mail time dealing with low-priority messages that require no action from you.
- When listening to voicemail, it seems that messages marked urgent often aren't, while important messages are buried in the normal message queue.
- While at your hotel room, you use your modem to replicate your email, but it hangs up for three hours on a multi-megabyte attachment that someone sent to a distribution list you're on.
- When you send a message to someone else, you don't get a response for about an hour on average, and sometimes much longer. Is it because the recipient isn't around? Is he or she too busy to read your question? Or busy researching the answer?
- You need to contact someone, but you don't know what mail system he or she is monitoring. So you send the same message at least twice – once by phone to a voicemail system, and once in email. If your recipient is at a client site, you leave the message in voicemail there as well. After you have wasted time generating three copies of the same message, your intended recipient will waste time processing all those copies.
- You have an urgent need to find a fax that was sent to you last year. Did you file it? Did you even keep the paper? Are you traveling and away from your paper files, so someone will have to find the fax and re-fax it to you?
- You receive an important voicemail, which you want to save. How do you

file it? Will you be able to find it in three months when you need it? How do you search your voicemail archive for it? Wouldn't it be nice to be able to store it in one place with related email and faxes?

- You receive a voicemail from someone at another business unit. Since there is no sender information, you cannot reply to the message – even though it was sent from inside the company. You must find the person's voicemail address and send a new message.
- You have to send a message to a group of people. What distribution list do you use? And how do you determine the correspondence between voicemail and email distribution lists?
- You receive a voicemail that has been forwarded many times. Everyone who forwarded the message added his or her own explanation about why it's important that you listen. It takes five minutes to listen to all the prefaces before you reach the actual message.
- At an important meeting at the client's site, you lose valuable time in front of the client because you need to check the phone for important voicemail. And email? At a client? Forget it.
- You return from vacation to a full voicemail box. Do you spend your first half-day back dealing with old business? How do you sort out the important messages from the routine ones?
- You need a question answered by someone on your project team. You send a message to all 10 of them. Six of them take the time to research the problem and send you the answer – wasting the time of 50 percent of your team.

Why go through the list of problems in such detail? Because most of us take at least some of them for granted. This is simply the way voicemail and email work. Since most of us can't conduct business without using messaging services, we put up with the inconveniences. But the inconveniences become more significant as we travel more, as the number of messages we are called upon to handle per day increases, and as the content of those messages becomes more critical to the success of our business.

Through a fortunate accident of timing, the tools to solve this problem are developing almost concurrently with the problem itself. The merging of the Internet and the mobile device industry allows the development of new products and Internet-based services for generating and receiving messages. And these tools are starting to reach the market – both integrated tools that deal with the problem from end to end, and components that focus on solving small pieces of the puzzle. Using these tools, it is possible to start developing a true messaging architecture, replacing the existing system of independent message stovepipes.

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Design Goals for a Pervasive Messaging Architecture

A system intended to provide structure for enterprise messaging should meet the following design goals:

- *Mailbox consolidation and flexible delivery.* Let both the sender and recipient choose their preferred message medium. A recipient should be able to use the telephone to receive a message that the sender chose to send by email. Both sender and recipient should be able to change their preferred medium (telephone, PC, PDA, pager, fax) as their location and connectivity changes.

- *Queue management tools.* Regardless of the recipient's choice of mail client, the client software should provide context about all inbox messages and give the recipient control over the order in which the messages are read.
- *Conversational message exchange.* Deliver certain kinds of messages quickly and passively – without requiring any action on the part of the recipient – directly to a device of the recipient's choosing. This style of messaging allows people to carry on a real-time message exchange with near-zero delivery times, offering bandwidth approaching that of a telephone or face-to-face conversation.
- *Presence advertising*. Allow people to indicate their availability to receive messages right away. A complementary facility should exist to allow someone to monitor the availability of a select group of other people. This is the equivalent of walking down the office hallway to see who is in their offices; it is a vital component of collaboration.
- *Effective notification of incoming messages*. Allow either the content of a message or its envelope information to be forwarded to a device of the recipient's choosing. This includes the ability of the recipient to easily define filtering rules for automatic prioritizing of incoming messages, so he or she is notified only of the messages that actually need attention.
- *Automatic message routing based on presence.* In an ideal world, a wire-line-based device like a computer or desk phone should be able to detect and route incoming messages based on the proximity of
- the person who receives messages on that device. Just walking away from a wire line device should cause important messages to be routed to the recipient's portable phone, pager or PDA.

Implementations of almost all of the above features exist in products that are available today. However, most of those products use proprietary communication standards, and integrating some of them into a single working system would be a challenge. As of this writing, the first full-service products for the integration of messaging systems, containing most but not all of the features listed above, are reaching the market. As is true of many new products, they are not yet fully formed, so there is a strong opportunity to partner with the product vendors and influence their designs. They represent the first concerted effort to define an architecture for all forms of corporate messaging.

THE DESIGN GOALS IN DETAIL

Mailbox Consolidation

The most fundamental change required in the redesign of messaging is the consolidation of incompatible systems. The lack of interaction between email, paging and voicemail, and even between individual voicemail servers, is responsible for much of the inefficiency of current messaging architectures.

Consolidating content: the challenge of competing systems

All messaging systems are built around a single message type. Email is based on plain text, voicemail on audio, and fax on images. These message types cannot be joined unless each underlying messaging system is capable of handling all message types.

Email systems are already well suited to the presentation of other types of content. Importing that content from other messaging systems is the greatest challenge to be overcome in transforming email into a single messaging client. Importing images sent by fax is not an obstacle, since a telephone-based transport provides an easy interface with computer-based messaging. Stand-alone fax solutions like RightFax and Spectrafax have been widely deployed for years. Importing voicemail presents the biggest problem because the proprietary nature of almost all commercial voicemail systems makes transfer of messages to other systems – even other voicemail systems from the same manufacturer – difficult or impossible. For this reason, the integration of voicemail is the most serious potential roadblock to the creation of consolidated messaging solutions.

To consolidate dissimilar mail systems, messaging systems must be able to translate a message from its native format to the format desired by the recipient. The ability of the message sender to route a message to a dissimilar device is also an important part of mailbox consolidation. A sender with a pager, for example, should be able to choose to route a message to a fax machine, voice mailbox or email box.

The following table and text illustrate and explain some common approaches to message translation:

From \ To	Email	Voicemail	Fax	Page
Email	(Native)	Text-to-speech, attachment forwarding	Fax gateway	Pager gateway
Voicemail	Audio file attachment	(Native)	Notification only	Notification and translation on request
Fax	Graphic rendering of fax	Notification and fax forwarding	(Native)	Notification and fax forwarding
Page	Mail forwarding	Text-to-speech, attachment forwarding	Fax-to-pager gateway	(Native)

Audio file attachment: The voicemail system is capable of converting incoming voicemail into a standard sound file format and forwarding it via email. In most cases, the recipient must have a sound-enabled PC. However, some systems will dial a specific telephone at the recipient's request and play the audio message. This feature enables a recipient to listen to messages more privately than would be possible on a speaker-equipped PC. It also allows a mobile worker to use a PDA or other connected portable device to manage the voicemail queue, even if the device itself does not support sound output. The technique of using a device with limited capabilities as a message queue manager and message router is becoming more widespread and is a key to enabling wireless management of unified messaging.

Audio file attachment is also used by unified messaging systems to allow an email user to address a dictated message to a voice mailbox. Finally, the ability to forward voice messages to an email system allows the archival of voicemail messages, a feature that is difficult or impossible in most voicemail-only systems.

The biggest factor limiting the adoption of audio attachment and other alternative interfaces to voicemail is the proprietary architecture of most current voicemail systems. Limiting external access into the voicemail message store is seen as a competitive advantage, since it locks a customer into a single voicemail vendor for the enterprise. Interaction between voicemail and other messaging systems like email is likely not a major factor in the decision to keep voicemail systems closed, but the consequence of this business decision is to force most companies to replace their current voicemail systems in order to implement a unified messaging architecture.

Some limited protocols are available for transferring messages in and out of voicemail systems, but they are not widely adopted and are mostly impractical. The most common of them, called Audio Messaging Interchange Specification (Analog), or AMIS-A, transfers messages in real time via phone calls between two voicemail systems – hardly viable for high volume message transfer.

Eventually, the use of *voice over IP* (VoIP) technology will merge data and telephone communications onto a single carrier and make the integration of voicemail and email much easier. The adoption of this technology has been fairly slow, however.

Text-to-speech: Support for vocalization of text messages is becoming far more common, and enables a voice interface to email for people who prefer to interact with the telephone. It also allows access to email for people who do not have easy access to a text-based device – for example, a traveler checking messages in an airport.

Some messaging systems support audio file attachment capability, allowing a voicemail user to dictate a response back to an email user and close the email-telephone-email circle.

Text-to-speech also allows people access to their messages in a secure client environment, where a client firewall or restrictions against data calls on analog modems prevent direct connection to an email system. Voice calls are generally not subject to security restrictions, except in the most sensitive work environments, so the ability to listen and respond to email by telephone makes email access possible where it would not be otherwise.

Fax gateway: Proprietary fax server systems supporting graphic rendering and email delivery of faxes have existed for years. These systems generally require an independent server and separate telephone numbers for each recipient. Many phone systems integrate fax and voicemail, so the recipient's telephone number and fax number are the same, but only now are unified messaging systems taking the next step to integrate fax, voicemail and email. The continued importance of fax in the future is widely acknowledged by the designers of unified messaging systems. In fact, the integration of fax and electronic delivery frees faxing from two of its key

limitations – dependence on paper and location-based delivery – and opens up new uses for this old messaging method.

One of the most interesting uses developing for fax is *attachment forwarding*. This is an answer to the problem of dealing with rich content on small, mobile devices. It is impractical at best to view a PowerPoint presentation on the screen of a cellular phone or PalmPilot, and impossible to listen to one in voicemail. A messaging system with attachment forwarding capability can extract the attachment and forward it to a fax number specified by the recipient, treating the fax machine as a remote printer. Thus a traveler can stop at an airline club, hotel desk or even Kinkos and pick up a paper copy of the attachment. The ubiquity of fax machines, combined with the freedom to route a fax document to an arbitrary machine, effectively raises the bandwidth of wireless messaging and allows traveling users to process much richer content when on the road.

Unified messaging should be the cornerstone of any new messaging architecture, but it is only recently that products and services with a useful level of integration have reached the market. Small-scale approaches to unified messaging have existed for approximately the past year. Client-based products like Communicate! Pro from 01 Communique can turn a PC into a personal fax, email and voicemail system able to translate messages from one form to another and present them in the recipient's desired format. Web-based services like Portico, Wildfire, eFax and onebox.com offer a similar consolidation of mailboxes, providing a phone/fax number and an email address and the ability to render any incoming message in any format. But only in the last few months have systems become available that scale this capability to the enterprise.

One goal of mailbox consolidation is to make better tools available for people who need to check their messages but have no access to a PC

Queue Management Tools

A good deal of the inefficiency of voicemail is due to the inflexibility of control over message presentation. Messages are presented in chronological order, with no context available until the message is opened. Even then, context is limited to the caller's identity if the call originated from a known user of the recipient's voicemail system; if the call came from outside, even that information is usually unavailable. Compounding the inefficiency is the difficulty of navigating through messages in any order other than earliest-to-latest. Even the simplest forms of sorting messages, such as latest-to-earliest or by sender's name, are beyond the capability of almost every voicemail system. For proprietary voicemail-only systems, this situation is unlikely to change.

The ability of consolidated messaging systems to present email and voicemail as a single set of messages is a big step in improving the usability of voicemail. Most consolidated systems provide the same sorting capabilities for voicemail as for email. Many also provide visual controls for message playback, making it easier to "see" the important parts of a message during playback and jump back to those spots by dragging the mouse.

The integration of playback controls into voicemail dramatically reduces the time needed to review voice messages. A time-and-motion study performed by AVT Corporation, makers of the CallXpress unified messaging product, showed that network-based users were able to check a mix of voice, fax and email messages over 50 percent faster when all messages were consolidated in a single mailbox and presented on the PC. Mobile users required less than a third the amount of time to deal with the same mix of messages using a single PC-based client.

Non-PC interfaces for reading mail

While it is fairly obvious that the PC is an excellent medium for dealing with messages, one goal of mailbox consolidation is to make better tools available for people who need to check their messages but have

no access to a PC. The limitations of the telephone make voicemail-only solutions problematic, although adding sort-by-user or most-recent-first capability to the mailbox would help a great deal. But consolidated messaging provides other tools for dealing with voicemail queues. A list of messages, both voicemail and email, can be displayed on a pager or text-enabled cellular phone, just as it can be on a PC screen. Such a list can also be faxed. Once a list of incoming messages is in the recipient's hands, interaction with the telephone-based voicemail client can be more productive. The recipient can listen to specific messages, skip others, and file still others in a "to process later" folder, reducing inbox clutter.

Conversational Message Exchange

Conversational messaging is a fairly new means of message exchange when compared to email and other traditional messaging technologies. But it is quickly coming into common use and is a key part of any new messaging architecture. The various systems for this kind of messaging are commonly grouped together under terms like *instant messaging* (IM) or Quick Messaging (QM).

In an instant messaging environment, a user runs a client on his or her messaging device, usually a PC. Other people can send messages to that client. Unlike email, these messages are generally delivered less than a second after being sent, and are displayed in a pop-up window on the recipient's PC or other device. Although the concept of instant messaging is associated with short messages, most existing instant messaging systems place no size restrictions on messages and allow the delivery of rich text and non-text content.

The effect of virtually instantaneous, guaranteed delivery of messages creates a conversational environment very different from the exchange of email. While most people take a "batch" approach to reading email, checking periodically for messages and dealing with them asynchronously, instant messaging encourages a more synchronous and interactive style.

One benefit of this is that a large number of messages can be exchanged quickly, leading to faster resolution of many problems than is possible using email exchanges. Instant messaging also lends itself (more than email) to quick question-and-answer sessions. In this way, instant messaging can be considered a middle ground between telephone conversations and email; it is less intrusive than a telephone but more intrusive than email. Instant messaging provides much of the conversational spontaneity of a phone call, but like email it leaves a permanent record that can be stored and searched, a powerful advantage over telephone or face-to-face conversation. And its information bandwidth lies somewhere between those two messaging media.

Current commercial implementations of instant messaging include Mirabilis ICQ and AOL Instant Messenger (both owned by America Online), MSN Messenger (Microsoft), Lotus Sametime (IBM) and Yahoo! Messenger (Yahoo). Currently these services are seen by most of their hosts as a way to build their subscriber base. Lotus, the only exception, is also the only company that does not give away its instant messaging service for free. As a result, most providers fight against the interoperability of competing instant messaging services. AOL, the current instant messaging leader with the largest number of subscribers, uses every weapon from blocking software to lawsuits to keep other instant messaging providers from accessing its users.

The situation is very similar to the early eighties when proprietary online services like Prodigy and CompuServe each allowed their users to send email only to their own subscribers. For AOL to share its instant messaging user base with Microsoft and others would be like eBay letting registered users of other auction services bid in its auctions. The value of these services is largely in the channel, or community, that it develops. A company with a self-sustaining community like eBay's bidders and sellers, CompuServe's user community or AOL's instant messaging subscriber list has little incentive to share that value with competitors. As long as the size of a

company's instant messaging subscriber base is considered a competitive advantage, this situation is likely to prevail. Fortunately, two forces are at work to break down the walls.

The first is standardization. The spread of Internet mail standards in the business world and at universities drove commercial online services to allow their users email access to the rest of the world. The same thing should happen as the Internet's Instant Messaging and Presence Protocol (IMPP), being developed by a working group of the Internet's primary standards organization, the Internet Engineering Task Force (IETF), is adopted. This standard is currently under very active discussion in the working group. Controversies and technological limitations surround many details of implementation, particularly in the areas of security, allowable message content, implementations for wireless devices, addressing and connection methods. It is likely that these arguments will keep IMPP from becoming a full-fledged standard for at least 18 months and probably longer.

But official standardization is not the only force at work in the instant messaging universe. The adoption of instant messaging as a business and communication tool, along with the availability of commercial instant messaging services starting with Lotus Sametime, should create an incentive for the competing instant messaging providers to join the rest of the world.

Instant messaging communities are beginning to grow, just as the isolated email communities of the early eighties did. Eventually customer demands forced competing email services to interoperate, using Internet mail as the transport. Instant messaging should follow the same path, helped by the fact that virtually all instant messaging clients are already technically capable of interoperating; only the roadblocks put in place by the vendors keep a user of MSN Messenger, for example, from communicating with a friend running AOL's Instant Messenger. These roadblocks were literally implemented overnight; they could be removed just as quickly if their creators saw an advantage to do so.

Instant messaging is almost always implemented along with *presence advertising*, described in the next section. The ability to send messages for instant delivery is enhanced greatly by knowing whether the recipient is, in fact, logged in and ready to receive those messages.

Instant messaging in a wireless world

As powerful as instant messaging is, its usefulness is limited if a person can be reached only when near his or her own PC. One of the great opportunities and technical challenges of instant messaging is extending the capability to portable, wireless devices.

Portable instant messaging clients running on pagers, connected PDAs and cellular phones would allow people on the move to participate as full members in instant messaging communities, a far richer interaction than is possible with voice-only and simple text paging and messaging services. A mobile worker who can carry one or two devices that provide clients for instant messaging, voice and phone-based email and Web services is nearly as connected to other team members as a desk-bound worker. Mobile instant messaging can also offer a solution to the message notification problem, offering not just a portable "message waiting" light but a description of the message, or the message itself, as well.

Instant messaging should follow the same path as email—eventually, isolated systems will interoperate

Technically, implementation of instant messaging on a mobile device is difficult. Limited bandwidth, small displays and arcane text entry make most portable devices much less effective than a PC for the creation, transmission and display of messages. Maintaining the kind of persistent connection required for instant delivery of

messages (and presence) is a drain on the limited battery power of small devices. A recent project at one instant messaging provider attempted to use pagers as instant messaging clients because of their efficient power consumption; the project was abandoned because messages could not be delivered quickly and reliably enough to maintain the flow necessary for an electronic conversation.

Outside of the United States, one implementation of instant messaging for digital cellular phones has been very successful. Short Message Service (SMS) is widely available on GSM text-based phones in Europe; it has become a widely used delivery mechanism for text messages up to its 160-character limit. Messages can originate from a portable device or from an SMS-enabled Web site. To date, SMS as an instant messaging technology is a standalone service; messages to users outside the direct reach of SMS must be routed by conventional email. SMS also does not offer a presence service similar to most conventional instant messaging clients, as described in the next section. However, the similarity of SMS to instant messaging makes the two a natural fit.

Another significant development in wireless instant messaging may be on the horizon. AOL is preparing to make an announcement about a phone-based wireless client for its Instant Messenger service, based on equipment developed by one of its partners. Whether they have solved the technical problems, and created a practical portable instant messaging device, remains to be seen.

Presence Advertising

As described in the previous sections, a number of products at or near market deal with the issues of system consolidation, notification and integration of portable devices. However, none of the systems currently under study implement the concept of *presence* as it is defined in the world of instant messaging.

Presence is a developing protocol on the Internet, exemplified by commercial products like AOL's Instant Messenger. An active effort is underway to develop presence into an official Internet standard and extend its reach well beyond the PC platform where Instant Messenger and its competitors run.

Think of presence advertising as the opposite of the "message waiting" light on a telephone. The light shows that an incoming message is waiting for a recipient; the presence indicator shows that a recipient is available and ready to pick up an incoming message. Put another way, imagine that you could determine, before making a telephone call, whether the phone would ring and someone would be there to pick it up. For a person about to originate a message, presence is a powerful tool for deciding what medium to use.

The general implementation of presence is very straightforward. A network-enabled, message-capable device – most likely a PC, cell phone or pager – runs an agent that communicates via a network and registers the device with a central server. The device's registration message indicates that the device is online and declares whether it is willing to accept messages. Other network-enabled devices can ask the server whether that device is available and use the information to decide how or whether to send a message to it.

Most implementations of presence are enhanced by practical considerations like security and status (most commonly, the ability to restrict the set of people who can see a device's status, or the ability to advertise that a device or user is online but not accepting messages). But the idea that the online status of any device can be determined instantly is a simple, elegant and extremely powerful extension to any messaging system.

The use of presence is still not widespread. Few corporate IT organizations have dealt with presence clients because of the relative newness of the protocol, and few allow presence information in or out of their corporate firewalls. Widespread use of presence information is also hampered by the lack of interoperability among different presence systems. For example, AOL Instant

Messenger cannot see users on ICQ, another presence reporting system owned by AOL. AOL Instant Messenger also actively blocks Microsoft presence clients for competitive reasons, as described earlier in "Conversational Message Exchange."

The same IMPP working group that is developing Internet standards for instant messaging is also working on a standard for presence reporting and presence servers, but the group is far from agreement and will probably not finish the job for 18-36 months. In the meantime, proprietary solutions to the reporting of presence information are being developed and rolled out, generally bundled with instant messaging software.

Wireless presence
All implementations of presence released to date have been written for networked PCs. Software companies and wireless equipment manufacturers are finally starting to turn their attention to the significant technical issues related to implementing presence on wireless devices – primarily battery and bandwidth requirements.

Battery life is the thorniest of these issues. The ability to advertise presence and receive instant messages requires a wireless device to constantly monitor the airwaves for incoming data and to constantly transmit its presence status to its network. These are demands that cellular phones, wireless PDAs and pagers cannot meet. The constant transmission required by presence advertising would cut into the already marginal battery life of cellular phones and PDAs. Pagers achieve their long battery life by permitting delivery times of up to four minutes, and presence information would be subject to the same delays and granularity. The power management problem will need to be solved before wireless "always-on" availability becomes practical.

The importance of a wireless implementation of presence cannot be underestimated

The importance of a wireless implementation of presence cannot be underestimated. Giving wireless devices the ability to report that they are reachable and can check on the availability of other devices will allow intelligent routing of messages across all devices, whether wired or wireless. This, in turn, will enable truly adaptable messaging. When combined with a universal messaging solution, a sender can figure out who on his or her "buddy list" is immediately reachable and send a message to those people, knowing it will be automatically routed to the mailbox that is most likely to be checked at any given time. This may seem like a minor improvement, but it should give messaging a much more natural feel and far better usability, leading to dramatic changes in the way messaging is used.

Message Notification and Filtering

Notification and filtering are closely related and can be considered together. Moving the "message waiting" notification signal away from desk-bound equipment and making it fully portable is one of the most important ways to make messaging more effective for the mobile worker. It is also important to change the simple on-off nature of that signal and make it more informative than a light on the telephone or a beep and an icon on a computer screen. Once the signal carries more information than a simple "you've got mail," it becomes a relatively easy task to implement filters that will allow user control over which messages warrant notification.

For desk-based workers who already have notification indicators on their telephones and computers, improved filtering and the merging of voicemail and email notification are the important issues. For mobile users, filtering is also critical, but so is the transport mechanism used to get the notification to the worker. The key to effective notification is the development and widespread adoption of three technologies: Internet-enabled wireless phones, Internet-enabled PDAs, and two-way mobile text devices using paging standards or packet radio.

The importance of notification
The point of any message notification system, whether mobile or tied to a desk-bound device, is to make the delivery of messages a push, not a pull, operation. Without a "message waiting" light, a worker must constantly dial into his or her voicemail to find out if there are new messages. This is the usual condition of a worker when traveling: calling back into the voicemail system at every opportunity to check for and answer voicemail.

The situation can be better or worse for email users. At his or her office desk, a worker can generally check email status with little effort. But send that person on a trip, or to a meeting, or anywhere away from his or her PC and network, and the picture changes radically. Checking for the existence of email when remote requires far more effort than checking for voicemail. As a result, voicemail is the preferred messaging medium for many traveling workers – even when the content and nature of the message being sent lends itself to email.

Filtering: increasing the bandwidth of the "message waiting" light
Filtering is, pure and simple, the ability to apply a set of user-defined rules to incoming mail that determines what messages are important enough to warrant special treatment. That treatment generally involves making the message stand out among other message traffic, effectively screening or prioritizing all incoming mail.

For email, many cues can be used in the filtering rules: sender, text in the subject, text in the message body, whether the message is addressed to the recipient directly or to a mailing list that includes the recipient. Voicemail generally lacks these cues, occasionally offering the originating phone number of the message or sometimes, for internal senders, the name and phone number of the message sender. Due to the lack of reliable identifying information, most voicemail systems rely on the sender's assessment of whether the message is "urgent" as the only filter.

The portable "message waiting" light
Making notification portable, with usable filtering tools, is one of the simplest ways to extend the reach of traditional messaging systems. It is made possible by the growth in portable text messaging devices, including Internet-enabled phones from Sprint, Nextel, AT&T and others, and two-way pagers from every commercial paging service. Virtually all of these devices are accessible via an Internet email address.

It is within the native capability of virtually every modern email system to auto-forward messages, or information about messages, to another email address, so sending notification to a mobile user becomes only an exercise in writing appropriate filtering rules. Many voicemail systems can use more traditional paging methods to notify mobile users of messages waiting. The voicemail services included with many cellular phone plans usually offer richer notification, but at a higher cost and at the penalty of adding yet another stovepipe to the messaging architecture.

A better solution is being offered both by enterprise messaging vendors like Lotus and providers of individualized solutions like 01 Communique. These products make the notification interactive by allowing the recipient to respond to the "message waiting" light. He or she can tell the mail server to forward the message to another location, like a nearby fax machine or the email account of another person working nearby. If the portable device used for message notification is powerful enough, the message itself can be forwarded to the same device. In this way full content is available at the option of the mobile user without consuming the bandwidth that would be required to forward to the mobile device every message that matches the agent rules. This sort of interactive notification is one more example of the kind of synergies that are possible when a single system can combine the strengths of multiple messaging media.

Routing profiles
The flexibility of pervasive messaging leads to complexity. Giving each recipient a single

mail address for all messages simplifies life for the sender of a message, who no longer has to decide which representation of a person to use when addressing a message.

However, it complicates life for the recipient, who must now decide which mailbox represents him or her at any given time. This decision does not always yield the same result. Am I at my desk? Then my PC is the most efficient client for receiving all mail – it has the best screen, the best keyboard, the ability to process almost all attachment content, and multimedia capability for playing and recording audio. Have I gone to a meeting? Then my best bet is a two-way text pager or text-enabled phone with filtering, so I know when important messages arrive and from whom, and can respond to some of them, unobtrusively, without leaving the meeting room. Am I on the road? In this case pager notification and access to a telephone (cellular or pay) enable me to listen and respond to all messages, albeit inefficiently.

One part of the solution is to create *routing profiles* in the system. These profiles describe the preferred method of mail routing depending on the location of the recipient. For example:

- An "*In the office*" profile could say: "Notify me of incoming mail via a pop-up window on my PC, disable filtering so I get notification of all messages, and send all instant messages to my PC."
- An "*Out of the office*" profile could say: "Notify me via the message light on my cellular phone, filter out all messages except those that meet my defined criteria for importance, and send instant messages to the phone as well."
- An "*On vacation*" profile could use a different filter that blocks all instant messages and sends notification of mail only if the message contains a phrase that the worker told only to those people he or she decided should have access at that time.

To date, none of the systems studied provides this kind of profile capability, but it should be within the capability of any system that supports consolidated messaging and notification.

Automatic Message Routing

Maintaining the information in routing profiles can be difficult given the frequency with which many people move from office to meetings to the road. Further, using a manual process for updating a recipient's status is almost guaranteed to lead to errors. If a user forgets to tell the system when he or she is leaving for a meeting, important notifications may be missed. Allowing the user to update routing instructions from a wireless client solves the problem, but only if the user remembers to update his or her location information at some time. What is needed is a means for the system to automatically detect where the user is and set the appropriate routing profile based on this information.

Automatic message routing enhances the usability of a pervasive messaging architecture

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Bluetooth to the rescue?

A short-range networking protocol may provide the answer for automatic routing. Bluetooth is a new industry standard designed to replace infrared as a way to wirelessly connect devices to others within close proximity – currently 10 meters. Intended uses of Bluetooth include communication between PCs and PDAs for synchronization, between multiple PDAs to support information "beaming," between PCs and cellular phones to enable wireless connection to the Internet, and between cellular phones and headsets simply to eliminate wires.

The electronics needed to add Bluetooth capability are meant to be small, low power and cheap, so they can be added to any device that can benefit by communicating with other devices. The first Bluetooth devices are scheduled for release around the

end of March 2000. Ultimately Bluetooth transceivers will be small enough to fit inside a watch or key fob.

It is the portability of a Bluetooth device that makes it a possible answer for the automatic message routing problem. A Bluetooth transceiver in a personal article like a key fob or watch can inform a Bluetooth-enabled PC when its wearer is within range and an "In the office" profile should be used. While this is not a current direction for the developers of Bluetooth devices, it is a logical extension of the device's capabilities. And while it is the least important aspect of pervasive messaging, automatic message routing capability would enhance the usability of a pervasive messaging architecture.

PRODUCT AND SERVICE REVIEWS

The changing environment and rapid evolution of messaging systems make it difficult to pinpoint a single strategic product or set of products that should be central to a pervasive messaging implementation. A comprehensive evaluation of these products is beyond the scope of this paper. The products described here, most of which are referenced in this paper, address one or more of the issues discussed and can be used as the basis of a pervasive messaging architecture today.

Lotus Unified Messaging Strategy and Mobile Services for Domino
http://www.lotus.com/home.nsf/welcome/mobile

In October 1999 Lotus announced an initiative with several partners to create a **unified messaging** environment based in Domino. The objective of the Lotus offering is to allow access to email, voicemail and fax messages from a single client of the recipient's choosing, under the slogan "anytime, anywhere on any device." Lotus UM offers access to incoming email, voicemail and fax through a single inbox. The inbox can be accessed via a Web browser, Notes client, telephone or wireless PDA. The inbox actually is a front end that hides up to three separate message servers for email, voicemail and fax, but the ability of all servers to communicate and transfer messages makes the separate message stores relatively unimportant.

The cross-media capability of Lotus UM allows a user to listen to email on the phone, receive voicemail as a .WAV attachment to an email message, route text messages to a fax machine and send faxes to a computer screen. Voicemail can be routed to a nearby telephone, a useful alternative to PC speakers when listening to voicemail in a public place. A call-back feature allows a message recipient to automatically call the sender of a voicemail message. A "follow me" service routes incoming messages and calls based on static rules set up by the mailbox owner; filtering automatically assigns priorities to incoming messages. The "message waiting" light can be used to signal incoming email as well as voicemail.

For wireless users, the UM system allows the rule-based filtering and routing of message notification, short messages and full-text messages within the capability of the receiving unit. Messages originating on the wireless device can be processed through the user's corporate mailbox. And the system includes tools for managing the incoming message queue from a wireless phone or PDA.

The gateway between email and voicemail is based on the CallXpress product from AVT Corporation. ROI studies conducted by AVT show time savings of 50-66% for reviewing messages over reading the same messages via traditional voicemail, email and fax queues.

CallXpress is dependent on the use of one of a specific set of compatible voicemail systems. The adoption of this product, therefore, would require that most companies replace their voicemail servers, a considerable barrier to entry for organizations with relatively new voicemail systems. But for companies willing to make the leap, Lotus UM represents the most complete enterprise-scalable product for pervasive messaging currently available.

American Mobile eLink
http://www.elinkmail.com/

American Mobile's eLink service is a promising alternative that addresses many of the problems of other mobile devices. eLink is a packet radio system that uses the ARDIS network. ARDIS was developed by Motorola for IBM's field service technicians. It was later sold to American Mobile, which continued to develop it as a general-purpose communication tool. The company's typical customer has a highly mobile work force that needs to stay in constant contact with a home base. United Parcel Service, one of AM's largest clients, uses ARDIS terminals to keep track of its trucks and to record package deliveries. IBM used the system more interactively, using ARDIS devices to send bulletins and keep field technicians at customer sites in

contact with experts who could answer their questions.

The standard device used by eLink is the RIM 850 data terminal. The 850 is the size of a pager, with a QWERTY keyboard and an eight-line screen that uses a clever thumbwheel control for viewing longer messages. It can run for a week on a single AA battery and can use rechargeable batteries as well. Messages can be received by and sent to the 850 from other ARDIS devices, Web-based clients, or any Internet email client. eLink can also send text messages to any fax machine. The device can handle text messages of any length. This differs from Flex-based paging services, which are limited to 500 character messages, SMS at 160 characters, or most wireless phone-based email services that also have fairly low character limits.

American Mobile offers its service at a flat monthly rate ($60 for a single user as of January 2000), with no usage charges. The predictability of a flat-rate pricing structure, unlike the usage-based pricing of cellular phone and pager plans, encourages optimal use of the system and makes budgeting for the service much easier.

The ARDIS network also lends itself to secure messaging. The network tracks the location of each client device and sends messages over dedicated land lines to the transmitter nearest the client. The last step, from a single transmitter to the receiver, is the only time a message travels over the air. ARDIS servers can be installed inside a corporate firewall and connected via leased line to the American Mobile distribution network, providing a secure path for email directly into the corporate infrastructure.

American Mobile's RIM 850 data terminal could be the first practical full-function client for wireless text messaging

The design of the ARDIS system and its Internet gateways lend ARDIS to implementations of presence reporting, presence checking (see later section for more on presence) and instant messaging.

American Mobile has shown some interest in developing services that interoperate with a standard PC-based instant messaging product like Lotus Sametime. With the appropriate software and gateways in place, according to American Mobile engineers, message delivery times below 10 seconds should be fairly easy to achieve. Combined with multi-day battery life, flat rate pricing, the ability to serve as an email client, and the support of presence advertising and presence checking, the RIM 850 could be the first practical full-function client for wireless text messaging.

Motorola Email VClient
http://www.motorola.com/MIMS/PSD/products/vclient/vclient_overview.html

VClient is a free application for the Motorola PageWriter 2000 family of two-way, keyboard-based pagers. Through gateways (that are *not* free) VClient interacts with Lotus Notes, Microsoft Exchange, standard POP and other mail systems to provide agent-filtered mail forwarding from a user's inbox to the pager. Messages can be read and responded to; replies are forwarded through the user's mailbox to eliminate the cryptic return address generally associated with pager email. VClient's agent settings can be changed from the pager.

An associated service, Faxaway, is available from paging outlets like Skytel; it allows messages and attachments to be rendered and forwarded to a fax machine.

Lotus Sametime
http://www.lotus.com/home.nsf/welcome/sametime

As the first instant messaging product targeted at enterprise customers, Lotus Sametime ties together corporate and global instant messaging and presence through interoperability with AOL Instant Messenger. It also includes full T.120 standard multipoint conferencing, making it compatible with Microsoft NetMeeting. (By including a meeting server and other features that are not part of the NetMeeting design, Sametime fully meets the T.120 standard while NetMeeting does not.) Sametime shares its address book and

password authentication list with Lotus Notes/Domino, making it an easier fit for enterprises that already use Notes.

Sametime provides a very rich communications environment. Supporting this environment is the Sametime Server, which tracks presence information, routes instant messages, authenticates users against a database that can be synchronized with a Notes public address book (PAB), and hosts online conferences via the T.120 standard created by the International Telecommunications Union.

Sametime conferences can include users of other T.120 clients like Microsoft NetMeeting. Unlike NetMeeting, in which individual client computers act as the central connection point for all meeting participants, Sametime hosts all meetings at the server. This means that, unlike NetMeeting, the continuity of a meeting is not dependent on the stability of a single client computer– a significant advantage.

Further, Sametime can restrict its conferences to people who have logged into the server. This is in contrast to NetMeeting, whose servers are open to anyone who can find them on the Internet.

For security, a Sametime server inside a corporate firewall can communicate with a proxy server in a DMZ or the open Internet, extending Sametime directory services to workers outside the corporate intranet. The connection between server and proxy can use virtually any standard secure communications protocol.

T.120 meetings can take advantage of shared onscreen whiteboards and chat windows. They also support shared applications, allowing all participants to either view or manipulate documents and applications running on someone else's computer.

The instant messaging and presence facility of Sametime is also managed by the Sametime Server and requires authentication against a Notes address book. This means that a Notes community can instantly become the foundation of an instant messaging community. Further, Sametime can authenticate against AOL Instant Messenger, so a user with an AOL Instant Messenger account can monitor, advertise presence and conduct Instant Messenger conversations in both an internal corporate Sametime community and the public AOL instant messaging community using a single on-screen client.

Lotus is actively investigating enhancements to extend the reach of Sametime instant messaging and presence to wireless devices.

Motorola PageWriter 2000X and SkyTel Paging Service
http://www.motorola.com/MIMS/MSPG/SmartPagers/

One of the first two-way wireless email clients made available to the public was the Motorola PageWriter. The first PageWriters had a five-button control that navigated an on-screen alphabet in lieu of a keyboard. The PageWriter 2000 and 2000x, introduced in 1997, offer a fully functional (if small) data terminal with a QWERTY keyboard, nine-line display, and an operating system that can support third-party applications.

The most important function of a pager is messaging. SkyTel's two-way service provides a coverage area almost as complete as the best nationwide cellular phone providers, with better coverage inside buildings where cellular phone signals often fail to penetrate. The service includes message confirmation, which allows senders to know when their messages are delivered to the recipient's pager. Message delivery also provides error correction; the service will continue to send the message until it is error-free. It is not uncommon in a fringe reception area for a message to be corrected as the recipient is reading it.

SkyTel and other service providers offer a gateway between their paging networks and Internet email, allowing PC-based users to communicate with paging clients using any email program. However, the messages are subject to the 500-character length restriction of any pager message. In addition, the design of the paging protocol causes the pager to check messages for only 15 seconds out of every four minutes,

frequently causing short delays in message delivery. These delays are fairly insignificant for the typical exchange of pager messages, but they are unacceptably long for the delivery of instant messages. For this reason, pagers are not likely to be suitable instant messaging clients.

A primary reason for these periods of dormancy is power conservation. The PageWriter 2000 will run for a week or more of heavy use without a recharge, making it possible to take business trips without carrying a battery charger. For normal paging functions, a four-minute maximum message delivery time is an insignificant price to pay for battery life that is measured in days instead of hours.

The cost of paging services is a mixed bag. Monthly basic service for SkyTel costs between $30 and $55, the variance due to extras like voicemail and service contracts. This includes 800 10-character blocks of text either sent or received, enough for most

For normal paging functions, a four-minute maximum message delivery time is an insignificant price to pay for battery life that is measured in days instead of hours

people to easily get through a month of use. However, once the monthly minimum is exceeded, costs rise dramatically. Additional messages are charged at 10 cents per 10-character block, so a 91-character message costs $1.00. For those using the pager as a primary email device while mobile, or for subscribing to information services, monthly bills can rise into the hundreds of dollars. It should be stressed that this will affect only the highest-volume users, and that people quickly adapt their usage to fit the constraints of the billing plan.

Costs aside, a number of useful information services are available to take advantage of the pager's connectivity, text handling and always-on design. These services use an email model, in which the pager user sends a request to an information service and receives a message containing the requested information.

PocketGenie from WolfeTech (www.wolfetech.com) is the best of these services, offering stock quotes, driving directions, location of nearby UPS and Fedex drop boxes, address look-up based on name or phone number, sports scores, and weather and flight information. Because the pager is always on, PocketGenie offers agent-based services, including package tracking for UPS, FedEx, and the U.S. Postal Service, in which the package number is entered and a message is sent to the pager every time the package passes through a checkpoint. This kind of reporting is ideal for pagers, where immediate message delivery is not a critical issue.

PocketGenie, a subscription service, costs from $10 per month for 50 uses to $30 per month for unlimited use. The cost of the extra characters sent to the pager is additional, so excessive use of the service can raise the monthly cost by far more than the $10 to $30 basic fee.

A service similar to PocketGenie is offered for no cost from hz.com (www.hz.com). Hz.com is more limited in the range of information offered, although it does include valuable services like weather; flight status; next flight out (useful if a flight is cancelled); stock quotes; package tracking for Fedex, Airborne and UPS; driving directions; and zip code look-up.

This service also offers some highly unusual information, such as Whois information for looking up the owners of Internet domain names, recent lottery numbers, the previous night's Top Ten list from the David Letterman show, and even Bill Gates' current net worth. A useful feature is an auction agent, which tracks the status of auctions on Amazon and eBay and sends a message when a new bid is placed. Unfortunately, the slow response of the pager makes this service useful only during the early phases of an auction.

Note that while the hz.com information service is free, the user still pays for the characters sent to and from the pager. This

can make hz.com a very expensive "free" service.

Other services, both fee-based and free, illustrate the versatility of the PageWriter and the paging service. StockBoss 2000 monitors and charts stock prices, using the graphical capabilities of the PageWriter screen. Hurricane presents a map of the U.S. East Coast and plots the progress of hurricanes based on information sent four times per day. VClient, described earlier, provides email connectivity to Lotus Notes, Microsoft Exchange and Netscape mail. These and other applications are available for download at: http://www.motorola.com/MIMS/MSPG/SmartPagers/pw2000x/pw2000x_software_upgrades.html

Overall, the PageWriter and related services are a very workable solution for mainstream short messaging. The PageWriter provides a service similar to, and in many ways better than, the Short Messaging Service (SMS) available in most of the rest of the world. It offers reasonable message length, reasonable delivery times, reasonable size and weight, reasonable keyboard and screen usability, outstanding battery life, and connectivity with Internet email at a low monthly cost if used within reason. It is not a solution for high-volume users or for instant messaging, but as an alternative mail client for the mainstream mobile worker it is a very effective device.

General Magic Portico
http://www.genmagic.com/portico

User BBS at:
http://www.generalmagic.com/ubb/cgi-bin/Ultimate.cgi?action=intro

In contrast to mailbox consolidation products like Lotus Unified Messaging, Portico offers an Internet-based service that provides email, voicemail, fax and pager integration. A Portico subscriber receives an email address and a phone number that can be used for both voicemail and faxes. All messages are placed in a single message store that can be accessed in a number of ways. A web page shows all waiting mail in a single view, listing envelope information. Faxes can be viewed onscreen, voicemail can be played on the PC's speakers, and email can be read the old-fashioned way.

Portico also offers a voice-controlled interface to allow telephone access to the same message store. Using the telephone, voicemail is played back normally and email is vocalized. For faxes, Portico will read the phone number, company name, and any other information left by the sender. The Portico user can then divert the fax to a nearby fax machine or send it to an email address as a graphical attachment. Using the voice interface, the user can also call back the sender of a message and then continue reviewing messages once that call is completed. Portico will also screen calls by asking the name of the caller and giving the subscriber the option of picking up the call or allowing it to go to voicemail.

Portico takes integration one step further, offering a calendar and address book that can be synchronized with Microsoft Outlook or the PalmPilot. And a "follow-me" feature allows the Portico subscriber to specify a list of places where he or she can be found – phone numbers, email addresses, pagers – and have Portico try all of those places to connect an incoming call. This profile of numbers can change automatically based on time and day or can be changed manually.

Portico offers two pricing plans. The basic plan costs $9.95 per month and 15 cents per minute. The power plan is $124.95 per month and 12 cents per minute, with 1,000 free minutes per month. With the breakeven point for the power plan at almost 13 hours of use per month, only true power users are likely to select that option.

The Portico service is an early product with typical early-product problems. Recognition of voice commands is spotty, especially in noisy environments. The mailboxes cannot yet be integrated with a user's main email and voicemail systems, so unless one adopts Portico as his or her only mail system it becomes yet another stovepipe to be checked for mail. If offered as an internal application for corporate messaging, Portico would be a compelling product, but to date it is offered only as an Internet-based service.

Wildfire
http://www.wildfire.com

Wildfire is a service offered by mobile phone vendors that provides voice-activated management of incoming voice messages and contact lists. Like Portico, Wildfire offers voicemail-related services like dial-back, call screening and routing, and message forwarding. However, Wildfire is currently a voicemail-only service. Wildfire's web page claims that the product supports email and faxes, but none of the mobile phone companies that offer Wildfire support those services. Also, the only access to messages is through the telephone; there is no PC-based client for checking the Wildfire inbox. So for the time being Wildfire is a solution for voicemail users only. It is interesting for two reasons: its voice-based user interface could easily handle email and faxes, and an enterprise version for corporate intranet use is in the works.

Onebox
http://www.onebox.com

Onebox is a mailbox consolidation service similar in concept to Portico but oriented more toward the PC user. Like Portico, a Onebox subscriber receives a phone/fax number and an email address, and all messages are routed into a single message store. Unlike Portico, Onebox lacks a voice-based interface for reviewing messages; the telephone commands are generated via the telephone buttons like a conventional voicemail system. The Web environment is richer, with faxes presented as on-screen graphics and voicemails as sound attachments that are playable on the PC.

Unfortunately, saving a voicemail file on the PC is far from intuitive, relying on the "save as" feature of the Web browser. Forwarding a voicemail to another email account just mails the user a link to the sound file on Onebox.

Email attachments like Word documents are presented as plain text if possible and made available for download otherwise.

While Web-based users can access all types of mail, telephone users can listen only to voicemail. There is no email vocalizer offered in Onebox. Further, the telephone number assigned to a Onebox user has an extension. The use of phone extensions allows Onebox to host many users on a single phone number, but it can confuse many fax machines.

Onebox has one of the same drawbacks as Portico. Since it doesn't integrate with other voicemail or email systems, it simply gives a subscriber one more mailbox to check. Fortunately that's easy to do, at least for Web-based users.

Counterbalancing the drawbacks of Onebox is the price: it's free.

eFax
http://www.eFax.com

eFax is another free service, focusing on fax delivery. It offers a fax number and delivery of incoming faxes via email. There is no provision for outgoing faxes.

eFax has recently added eFax Voice, a voicemail service that runs on the same phone number as the fax service. Voice messages are delivered as audio attachments via email, so they can be saved, filed and forwarded just like any other file on the PC. This is a tremendous advantage over conventional voicemail. Both faxes and voicemail are played using a special eFax reader program on the PC. That program allows faxes to be saved in .TIF format and voicemails in .WAV format so they can be handled by standard PC programs.

The simplicity of eFax leads to its greatest advantage over other available services. eFax offers no internal email service, forwarding both faxes and voicemail to the subscriber's own email address. This allows consolidation of voicemail, email and fax into a single mailbox. Message pickup is solely through the email client – no voicemail or Web access. Each user is assigned a unique phone number, so there is no extension to confuse a fax machine.

And since messages are forwarded as soon as eFax receives them, there is no new message store to manage at eFax. As a service that doesn't create a new messaging

stovepipe, eFax is a better solution today than most for integrating voice, email and fax – as long as you don't mind accessing all your messages from a PC.

Bell Atlantic Follow Me
http://www.linxcom.com/

Real Video news story on:
http://www.necn.com/vidload/?vidname=/2000/01/26/1600bz01

Follow Me is an upcoming service that will soon be resold in New England by Bell Atlantic Mobile. Created by Linx Communications as LinxConnect, Follow Me, like Wildfire (Linx Communications also owns Wildfire), includes call screening and call back. It does not support the Wildfire voice command interface, but it does have several compelling features that Wildfire does not.

Incoming voice messages and faxes can be forwarded to an email account and viewed on a Web page. And Follow Me can be set to ring multiple phones and pagers simultaneously when a call comes in– probably disconcerting if you're near your land line, pager and cell phone at the same time, but something worth getting used to. The video link above shows four phones ringing at once. The first phone picked up takes the call.

Bell Atlantic Mobile has priced the service at $10.99 per month for 100 minutes of use. The fact that Follow Me will integrate with an existing email account makes it, like eFax, a viable solution that does not create a new messaging stovepipe. It is superior to eFax in that it allows both telephone and Web access to messages and integrates with the subscriber's own mobile phone. For an individual, Follow Me is the closest thing to a consolidated mailbox on the market today.

Wireless Mail for Notes
http://www.martinscott.com

Most products that link conventional email to wireless devices require some change to the email infrastructure. However, Martin Scott's product for Lotus Notes, Wireless Mail, uses Notes agents to allow each user to implement a personal mail forwarding solution.

Wireless Mail is installed in a Notes mailbox to monitor incoming mail. Mail that meets user-set criteria for sender name or content is forwarded to the email address of the user's choice. This product is designed for wireless mail delivery, so any email-enabled pager or telephone can be designated as the target device. The product is aware of the limitations of many specific wireless devices, so it knows how to truncate and split messages for delivery to devices with limited text-handling capabilities.

Version 1 is free, simple and functional. Version 2 adds more filtering, compression and delivery options and costs $19. Both versions can be installed in a Notes mail template to provide an enterprise-wide mail forwarding solution.

Tests of the free version 1 product with Notes 4.6.3 show it to be effective. Although it failed to forward the text of some fairly simple messages, it generally got enough of the context across to allow the receiver to assess the importance of a message. The filtering in version 1 is based only on the sender's name, but that's enough in many cases – and filtering is vital to keep your phone or pager from being deluged by many unwanted messages.

For an individual, Follow Me is the closest thing to a consolidated mailbox on the market today

Since the agent installs itself in the server-based copy of the mailbox, there is no need to keep a computer up and running to process the incoming mail. The corporate Notes server takes care of analyzing the message stream and forwarding the messages you deem important.

Note that no large-scale testing of this product has been done. While it works well for a single user, adoption of Wireless Mail for Notes by many users may cause server instability.

CULTURAL ISSUES

It is common wisdom that technology cannot solve a cultural problem but it can certainly create one. The purpose of pervasive messaging is to give workers more control over the way they collaborate with co-workers, clients and others. However, the availability of information always raises questions about how that information should be used. One of the advantages of developing an overall architecture for messaging is that these questions are more likely to be addressed as part of the architecture rather than situation by situation.

It is not within the scope of this paper to address these questions. For the most part these are questions of policy; answers will vary from company to company. However, it is important to consider the effects of anytime, anywhere availability on people using the new technology:

- *More access equals less personal time.* Presence advertising and the routing of messages to portable devices will lead to a further breakdown of the barrier between work time and personal time. It will be left to each organization to determine how it expects its workers to respond to messages outside of traditional work hours. Related questions concern the use of filtering and deferred delivery to control the flow of work-related messages outside of working hours, and the use of company messaging technology, servers and client equipment for personal messages.
- *More access equals less privacy.* The advertisement of presence gives an employer a rich set of tools for monitoring the work habits and whereabouts of employees. Further, it is a small step from advertisement of presence on mobile devices to advertisement of location, either through determining what cell a portable device is in or through the related technology of GPS. This raises questions of employee privacy versus the right of the employer to know where a mobile worker is during working hours, an ethical dilemma best left to the experts but important to consider when designing and implementing a pervasive messaging architecture.

SAMPLE SCENARIOS – HOW PERVASIVE MESSAGING WORKS

Let's take a few of the problems listed at the beginning of this paper and see how they look from a pervasive messaging perspective.

Scenario 1: You're waiting for an important message, but you've got to attend a meeting. Before the meeting, you edit your mail filter and enter the phone number or email address of the person you're expecting the message from. As you leave your office, the Bluetooth proximity sensor on your PC detects your absence and switches your mail profile to "Out of office." During the meeting, your cell phone vibrates, indicating an incoming text page. You check the phone and discover that your message has arrived. You excuse yourself, take care of the message, and return to the meeting. *Issue: Notification. Benefits: Less time lost waiting; quicker response when the message finally does arrive.*

Scenario 2: You're on vacation, or onsite at a client with a restrictive email policy, or in transit, and have no PC or easy way to check your email. You are informed of important messages via your cell phone or pager. Periodically, you place a routine request that a numbered list of your waiting messages be sent to that device. You deal with any important voicemail by calling in and requesting a specific message by number. You deal with email by having it read to you over the phone, forwarding attachments to a fax machine at your client site, hotel, or the local Kinkos. If, during your trip, your filtering requirements change, you use your portable device to edit your filtering rules. *Issues: Queue management, filtering, consolidated mailbox, notification. Benefits: Less time spent on the phone checking voicemail; easier to keep up with mail queue status; notification of important messages.*

Scenario 3: You need to contact someone but you don't know what mail system he or she is monitoring. It doesn't matter. You use the medium you prefer to send a message to the person, who picks it up using the medium he or she prefers. If the message is important enough, the recipient has no need to monitor – the message will find him or her. If not, it will appear the next time the recipient checks for new mail – anywhere. *Issues: Consolidated mailbox, notification. Benefits: Shorter time between sending and receiving messages; reduced duplication of messages.*

Scenario 4: You need to retrieve a fax or voicemail you received some time ago. You search your unified message archive, which contains copies of all messages you've saved, regardless of format. If you're organized enough, you've stored these messages in project folders and attached keywords to the faxes and voicemails for easier searching. You search by project and keyword (or by date of receipt, if you're less organized) and search for the document you need among the search results. *Issue: Consolidated mailbox. Benefits: Archival of important non-text documents; improved search and faster retrieval; access to all documents from any physical location.*

Scenario 5: You receive a five-minute voicemail from your supervisor that has been forwarded many times. The important parts are the original message and your supervisor's comments; the rest, while useful, is less important than the time it would take to listen to it. You open the message from your PC's inbox. You see a screen control that looks like the buttons on a tape deck, with a slider to indicate your current position in the message. By moving the slider around and listening to short samples, you quickly determine the context of the message and find the important parts.

Companies that are prepared to take advantage of advances in messaging technology should enjoy a significant competitive advantage in worker productivity, particularly when those workers are not co-located

Issue: Consolidated mailbox. Benefits: Better control over playback of voicemail.

Scenario 6: You need a question answered by one of the 10 people on your project team; you know six of them will rise to the occasion. You check the presence monitor on your PC's screen, or request presence information about your project team on your pager. From those results, you find that four team members are online and accepting messages. You pick the person most likely to have the answer and send an instant message. Through an exchange of instant messages, you get the answer you want. You save the exchange in a text file and put it in your message store for future reference. *Issues: Presence, instant messaging. Benefits: Quick response; high bandwidth message exchange; efficient use of personnel; message archival.*

The remaining examples cited at the beginning of this paper can also be addressed by a pervasive messaging architecture. The end result is a system in which messages can be generated, replied to and stored more efficiently than is possible with currently deployed messaging systems. Given the mission-critical nature of messaging, these benefits should translate directly into more efficient use of time and to improved business results.

CONCLUSIONS

The Promise of Pervasive Messaging

Messaging via email, voicemail and fax is the lifeblood of any collaborative, decentralized organization. New and developing technologies are poised to radically change the way these person-to-person services are provided, much as the Web altered the way companies do business with each other and their customers. Companies that are prepared to take advantage of these advances should enjoy a significant competitive advantage in worker productivity, particularly when those workers are organized in non-co-located teams.

Missing Enablers

The speed of the shift to pervasive messaging architectures will be very rapid once the enabling technologies are in place. Among the missing critical enablers are:

- wireless devices with sufficient battery life to allow "always-on" operation
- non-proprietary voicemail servers designed to interoperate with other messaging systems
- two-way wireless text services operating at higher bandwidth and lower cost than current systems
- speech recognition systems good enough to enable voicemail to be translated to text
- standardization and widespread deployment of instant messaging and presence

Voicemail incompatibilities

Of these, the problem of incompatible voicemail servers is the most serious; it is more of a problem for large companies with complex voicemail architectures than for mid-sized and smaller companies that have a smaller investment in traditional voicemail servers. A pervasive messaging architecture that lacks wireless notification or instant messaging can still offer significant productivity improvements, but an architecture that does not include voicemail retains almost all of the disadvantages of traditional stovepiped messaging systems.

In the medium term, voice over IP may eliminate the incompatibility of voicemail systems by eliminating traditional voicemail systems entirely. Once voice messaging becomes just another Internet data type, the wall between voicemail and email vanishes.

Battery life

The limited power of portable devices is also a considerable problem, particularly for implementation of wireless instant messaging. The design of a small device is almost always the result of tradeoffs. In the case of portable connectivity, a major tradeoff is battery life versus response time. Cellular phones, which must constantly monitor the airwaves for incoming calls and transfer data (conversations) in real time, offer battery life generally under a day for standby and under an hour for actual use. This short battery life makes cell phones unsuitable for the "instant-on" use required to make a mobile worker always available for instant messaging.

Pagers represent the other extreme. Their battery life of a week or more results from a messaging architecture that checks for incoming messages for only 15 seconds every four minutes, and queues messages instead of processing them in real time.

This is clearly not a viable approach to power management for a voice-oriented device like a telephone. But voice is not the only messaging method that suffers from the pager's power management approach. The conversational pace of instant messaging is also impossible when a message can take up to four minutes for delivery. So, while pagers are useful for question-and-answer exchanges, they, like cell phones, do not allow a mobile worker to participate as a full member in an instant messaging community.

Speech-to-text

Before content-based filtering tools can be applied against voicemail, and before voicemail can truly be routed to all client devices, voice recognition technology must improve substantially. Tools to convert

speech to text are necessary to enable text-only devices to view the contents of voicemail, and filtering tools cannot apply rules to audio content they cannot understand. While clever workarounds exist, such as attaching audio files to email and routing voicemail to arbitrary phone numbers, mobile workers will not truly be able to manage voicemail from text devices like PDAs and pagers until the content can be read in the same way as email.

Non-traditional Mail Clients: A "Killer App?"

Pervasive messaging could be a seismic event in the development of computing systems and hardware. Messaging drives the sale of computer systems for two reasons: personalization and email access. Many people travel with laptop computers only so they can access their email on the road; this paper has shown that the PC's size and complexity make it less than ideal for this purpose. Alternate hardware for email access can be lightweight both in physical size and the complexity of its code, leading to less demand for general purpose PCs among mobile workers. It is arguable that mail clients, either dedicated or integrated with cell phones, PDAs, pagers or other small devices, will be the first "killer app" for the often-predicted Internet Device.

The introduction of lightweight mail clients could also accelerate the trend toward smaller, lighter, more portable computers. More effective mail notification and better alternative mail clients could move the PC along the same track the telephone is following, toward personal devices that are always with us instead of large boxes planted in a fixed location that we visit when we need what they have to offer. The best model for the development of both the telephone and the PC may be the calculator – once a large, desk-bound, shared piece of equipment that is now something small, light and personal.

Messaging could also be the impetus for another kind of killer app: the messaging service. While the client side of a pervasive messaging architecture requires a company or individual to invest in new and innovative hardware, back-end services can be purchased from an Internet-based service provider. These providers can offer unified messaging services to clients using the Web, a telephone, or any new device. The security needs of corporate messaging could be an issue, but there are certainly solutions available. These services are the public equivalent of the messaging servers that can be installed privately within a corporate infrastructure.

Some unified messaging services already exist on the Internet. Sites such as onebox.com and Portico offer a voicemail/email hybrid. Other sites concentrate on individual messaging media, such as Wildfire for voicemail/fax and eFax for Internet-based fax alone.

Helping companies understand the role of these technologies, and the architecture behind them, presents a significant business opportunity similar to that afforded by the introduction of the Internet as a business tool.

Instant Messaging and Presence: Bringing the Group Back Together

Instant messaging and presence can be considered independently of the rest of pervasive messaging; they are significant on their own merits. Presence makes it possible for a sender to direct a message to one or more people based on real knowledge of the recipients' ability to deal with the message right away. Instant messaging fills a critical gap in messaging media, combining the instant delivery and conversational pace of the telephone with the rich content, group orientation and archival capability of email. As a standalone system, instant messaging and presence greatly enhance the communication bandwidth of non-co-located teams. The ability to extend the instant messaging community to wireless clients makes it even more useful. And its ability to find out who is available to receive messages makes an instant messaging client a natural complement to email and the telephone as part of a pervasive messaging architecture.

Final Words

What goes around comes around; history repeats itself. In the office of 20-40 years ago, people occupied offices near their co-workers. Secretaries took messages and decided when one was important enough to justify interrupting someone's work. Changes in the work environment have eliminated the co-located team and the secretary as gatekeeper but not the team-based style of work that they enabled and supported. By improving workers' access to each other and their control over incoming messages, pervasive messaging uses technology to restore and improve upon the productivity of project teams.

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About the Author

Rich Stillman, data center director for CSC's Boston Development Center, conducted the research described in this paper from January-March 2000 under a CSC technology grant. CSC's Leading Edge Forum awards technology grants to employees based on their passion for a particular technology, its potential market importance, and its relevance to CSC. To see the work of other CSC grant recipients, visit the LEF web site at http://www.csc.com/lef.

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