Wireless Messaging

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Much has been made about the burgeoning field of personal communication services (PCS). An integral component of AT&T's "computing and communicating anywhere, anytime" philosophy is wireless messaging. This article looks at the field of wireless messaging, examining some of its technologies and identifying the technical challenges yet to be overcome.

Introduction

Wired messaging covers a broad and diverse array of products and services. Wireless messaging, however, is even more diverse because of the need to:

- Work with a wide range of physical layer interfaces,
- Allow for the mobility of the messaging terminal, and
- Add the required levels of security over open radio interfaces.

Wireless messaging has numerous facets and, thus, can be classified in a variety of ways: by technology, access methodology, geographic coverage, or market segment, to name but a few. This gives rise to numerous ways of providing value to end users. As such, there are potential opportunities for niche market players, as well as for those who address the broader-based markets through integrated solutions, to develop both products and services.

This paper is organized into four sections, beginning with "A Technology Perspective," a look at the technologies and products that are enabling wireless messaging. The second section, "Wireless Messaging Services," outlines several areas of interest in the wireless messaging service arena. Section three, "The Role of Standards," highlights the importance and impact of standards and regulation in this market. The paper then concludes with a summary of activities that AT&T is pursuing in the area of wireless messaging.

A Technology Perspective

An analysis of several wireless messaging architectures reveals a high-level model containing four basic elements:

- Wireless messaging terminals,
- An access network, either wired or wireless,
- A backbone transport network, and
- Application nodes.

This section discusses some of the enabling technologies found within these elements, with primary focus on the role of wireless access and wireless messaging terminals (see Figure 1).

Wireless Technology. Many varieties of wireless communications technology exist today to support the wireless messaging market. These technologies can typically be broken down into three main segments, based on their communication range:

- *Short-range* communications, from a few feet to a few tens of feet;
- *Medium-range* communications, from tens, to several hundreds, to thousands of feet, and
- *Long-range* communications, from miles to hundreds of miles.

These differing ranges, however, involve different performance characteristics in terms of bandwidth, error rate, and power requirements.

Short-Range Communications. The most common short-range communications device technology is that of infrared (IR). One of the earliest forms of wireless messaging technologies, IR devices gave rise to the wireless keyboard, wireless mouse, and various types of wireless "cabling" techniques for attaching peripheral devices to a computing platform. Early forms of IR devices were hindered by their low throughput capabilities and a stringent requirement for a line-of-sight communication path. Today, however, we are starting to see experimental IR-based LAN devices

operating at up to 100 Mbits/s[1], and which utilize diffuse IR techniques, thereby eliminating the strict-line-of sight requirement.

Another short-range wireless data technology that's applicable to wireless messaging is passive radio. Using modulated back-scatter techniques, passive radio is a key technology in the development of very low-cost, short-range communications devices. This technology is being looked at for a variety of applications, including automatic vehicle identification on toll highways; identification badges; and wireless tags and labels in support of telemetry, tracking, and financial applications.

Medium-Range Communications. The medium-range technologies being used for wireless messaging typically use low to moderately powered radio frequency (RF) devices. Using a wide variety of narrowband and spread-spectrum techniques, such as frequency hopping and direct-sequence techniques, products have been developed that can achieve very high throughputs. AT&T Global Information Solutions' (GIS, formerly NCR) WaveLAN® product, for example, is capable of 2 Mbits/s operation at ranges of up to 800 feet[2]. In the United States, these devices typically operate in the unlicensed portion of the radio spectrum, namely the industrial, scientific and medical (ISM) bands of 902-928 MHz[3,4]. This spectrum avoids the burden of frequency coordination and usage costs to the end user for ongoing operation within the band. In addition to local area network devices, this spectrum also is being used to support circuit-switched data transmission using terminals being developed for wireless, digital voice communications.

Long-Range Communications. Long-range data communications systems have used a variety of technologies. They are typically high-powered RF devices operated in licensed portions of the radio spectrum. Both narrowband packet-switched services and broader band packet- and circuit-switched services using terrestrial and satellite transmitters are common to these systems. These technologies are used to support wireless messaging services, ranging from telemetry to wireless portable data terminal and computer communication to varieties of fixed, mobile, and maritime communication services. Throughputs among the terrestrial-based systems vary, depending upon the available channel widths. Technologies supporting throughputs of up to 4.8 kbits/s are commonly available, while those supporting 19.2 kbits/s are just starting to emerge.

Panel 1. Acronyms and Terms Used in This Paper

AMPS — Advanced mobile phone service

CCITT — International Telephone and Telegraph Consultative Committee, now the International Telecommunications Union (ITU)

CDPD — Cellular digital packet data

CMOS — Complementary metal-oxide semiconductor fabrication technology

ETSI — European Telecommunications Standards Institute

General Magic Inc. — A Mountain View, California, startup in which AT&T has an equity position.

GIS — AT&T Global Information Solutions (formerly NCR)

Hard handover — Teardown of a call when it is switched from one cell to another.

IR — Infrared

ISM — Industrial, scientific and medical radio bandwidth

LAN — Local area network

LEO — Low Earth orbit

MAN — Metropolitan area network

MASC — MOBITEX asynchronous communications user interface

MOBITEX — Data protocol for wide area network, wireless data transmission developed by Ericsson Corporation.

OSI — Open systems interconnection

PCMCIA — Personal Computer Memory Card Interface Association

PCN — Personal communications network

PCS — Personal communications services

POTS — Plain old telephone service

RF — Radio frequency

RIP — Radio interface protocol

RISC — Reduced instruction set computer

Telescript* — A communications software package developed by General Magic

WAN — Wide area network

These technologies have existed for quite some time, but have had limited use because of their high cost of service or equipment. Inmarsat's satellite-based packet service charges $10/kbits, with a terminal cost of approximately $10,000. At these rates, a five-page document costs $100 to transmit (assuming 2 kbits/page). Until recently, these systems also required very bulky terminal devices—13 pounds in the case of the Inmarsat system. This was a hindrance to their acceptance but, due to advances in miniaturization techniques, advanced

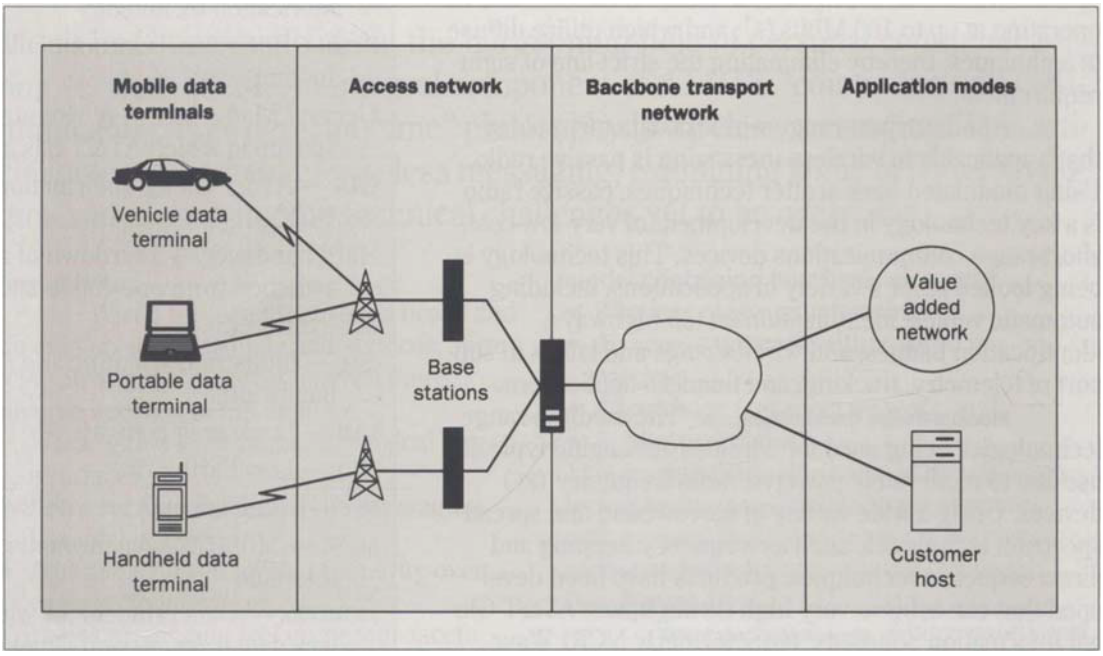

Figure 1. The wireless messaging network architecture includes a wide variety of players, protocols, and standards. Access devices include voice and data terminals in mobile vehicles, portable laptops, handheld voice and data terminals, and a growing number of telemetry and identification devices. Wireless access methods include cellular, personal communications networks (PCN), and wireless LANs. The backbone network can be wireless, such as satellite, or wired, such as fiber optic cables. Applications can be provided by the network or by value-added vendors.

antennae design, and digital signal processing power, some of these earlier problems have been overcome. The emergence of low Earth orbit satellites (LEOs) will offer even more opportunities for small portable terminals to communicate with antennae systems covering extremely large areas.

Messaging Devices. There has been a tremendous flurry of activity surrounding the introduction of new wireless messaging devices in recent times. Initially, these devices were proprietary, specialized pieces of stand-alone equipment. They had limited functionality, possessed a poor user interface, and were generally very bulky pieces of equipment. The advent and subsequent evolution of the laptop computer market, and the emergence of the credit card-sized Personal Computer Memory Card Interface Association (PCMCIA) interface as an industry standard, has helped to solve many of the shortcomings of these earlier devices. We are now starting to see an evolution toward standard, modular, compact, lightweight, multifunctional devices that are adaptable to many market segments.

AT&T Hobbit Chip. Numerous advances within the chip manufacturing community have been supporting the growth of wireless messaging. The emerging 3-volt technologies and their significantly reduced power requirements, combined with the increased price/performance exhibited by risk instruction set computing (RISC)-based processors, will continue to stimulate activities in this segment. An example is the AT&T 92010 HOBBIT chip, which has been designed to maximize processing power, while minimizing power consumption. Indeed, the manufacture of low-power chips is critical to the development of wireless messaging devices.

AT&T V32MX Modem Chip. Another key component basic to all wireless messaging devices is some form of modem. In the case of a wireless terminal device, and based on the open system interconnection (OSI) seven-layer model, the functionality will probably be divided as follows:

- Physical, link, and network layers (layers 1-3)—in the modem.
- Transport layer and above (layers 4-7)—in the terminal microprocessor.

The wireless modem generally consists, in simplified form, of three elements:

- Microprocessor controller,
- Digital signal processor to support sophisticated modulation techniques, and
- Radio to make the wireless connection.

AT&T's V32MX Modem Chip Set, using low-power consumption complementary metal-oxide semiconductor (CMOS) technology, is typical of what is being developed in the industry. This chip set can support a variety of wired and wireless protocols within a PCMCIA format, and supports the microprocessor control and digital signal processing for both wireless and landline modem functions, as well as for wireless telephony. The chip set provides a standard interface for the MOBITEX radio interface protocol (RIP) to interface with third-party radio transceivers. It also includes a standard MOBITEX asynchronous communications (MASC) user interface that supports standard application programs.

This highly configurable chip set now offers manufacturers the ability to create a software-defined radio modem which, depending on the attached radio module (MOBITEX, analog, digital cellular, etc.), can be adapted automatically or manually by the user to perform in a multitude of environments. The emergence of the PCMCIA interface standard, and a minimum set of radio and application interfaces, will stimulate rapid growth of the wireless messaging market.

A new generation of devices also is being developed to take advantage of today's improved price/performance in processing technology. These devices are designed with wireless communications in mind, and marry the concepts of high-power computing capability with the ease of wireless communication, the simplicity of an intuitive user interface, and the convenience of portability.

Their lightweight, compact size and energy efficiency make these devices extremely attractive, not only to corporate business users but also to the average consumer. These devices, known as personal communicators, personal digital assistants, personal information managers, etc., form the most highly publicized class of rapidly growing end-user wireless products. AT&T's EO Personal Communicator®, Apple's Newton*, and Tandy's Zoomer* are examples of this type of device. Using script recognition, stylus input, voice and data integration, and wired/wireless modems, the EO supports messaging, database access, and connectivity applications—all within a single platform.

Cordless and Cellular Technologies. Along more traditional lines, advances in cordless and cellular telephony equipment now yield additional opportunities for wireless messaging terminals. In the cellular arena, in addition to a migration to digital transmission, work is being done to overlay packet data on existing analog systems. One packet-switching option being developed in the United States is cellular digital packet data (CDPD)[5]. This digital packet-based technology, endorsed by the major cellular service providers in the U.S., shares the existing infrastructure of the analog advanced mobile phone service (AMPS) to provide packet-switched data services. Coupled with laptop, palmtop, and pen-based computing, this technology will yield a multitude of wireless messaging terminals to meet end-user needs.

Other terminal options are emerging that use circuit switching or packet switching over specialized mobile radio networks, such as the already mentioned MOBITEX networks of Europe and North America. Wide acceptance of facsimile messaging is encouraging the development of hybrid wireless messaging devices that support voice, data, and facsimile capabilities within a single unit, using a common radio interface. Portable, integrated multimedia devices, incorporating several of these technologies, will play a major role in allowing people desiring mobility to receive the full range of services that they now receive at a fixed location.

Wireless Messaging Services

Wireless messaging services, like wireless messaging products, can be grouped in a variety of ways. What we will see emerging is data-only services, data combined with voice services, image services, transaction services, and real-time data transfer services. All of these services are available over wired networks, and now need to be extended to the mobile work force.

One key circumstance pushing these wireless services is the emergence of a mobile work force, a portion of which is quickly becoming a global work force.

Table 1. AT&T study of mobile applications requiring packet-switched services.

Market segment	Percent of study	Percent packet
Field service	20	62
Field sales	10	50
Transport	18	90
Utilities	3	91
Insurance (agents/adjusters)	2	90
Reporters	1	40
Professionals (doctors/lawyers)	16	30
Public Service (police/first aid)	6	79
Fixed (vending machines)	24	99

Once such workers are untethered from regional and national wired networks, they quickly demand similar wireless circuit- and packet-switched access on a global scale. This growing mobility, and the nature of the wireless links, are forcing vendors to modify how they offer these services, in contrast to the equivalent wired, dedicated private-line offerings. The mobile worker needs to access global services via a variety of access technologies, including satellite links, paging, cellular telephone, public and/or private personal communications networks (PCN)[6], telepoint, and plain old telephone service (POTS)—all linked together by a worldwide intelligent network infrastructure.

Key ingredients in this vision include the concepts of:

- *Personal profile management*, which encompasses the idea of intelligently filtering information destined to the user, based on a user's dynamic identification of the filtering criteria,
- *Personal numbering*, which addresses the delivery of information to a user or a function, rather than to a fixed network end-point, like a pager number or Internet address, and
- The *virtual personal terminal*, which allows any terminal to negotiate and adapt to a user's preferences via a common user interface.

User Growth. Projections for growth in wireless messaging users range from 2.5 million to 9.4 million users by 1997, in just the United States. One forecast for the United States projected growth of one million to seven million users between 1992 and 1997.

Underlying these growth forecasts, however, are some basic assumptions about the infrastructure:

- Service will be generally accessible,
- User-friendly applications will be available, and
- Cost-effective subscriber devices will appear.

The sections above on wireless messaging technology describe several approaches that will increase service coverage, decrease the cost, and increase the functionality of terminals. In addition, the emergence of operating systems, such as Magic Cap,* and scripting languages, such as Telescript,* specifically designed to accommodate wireless messaging communications, will create an environment that will make it easier for developers to build seamless applications across the variety of LANs, MANs, and WANs that exist both in the wired and wireless worlds.

Wireless messaging services will become necessary for information workers, whose jobs require them to be away from their base locations, who must be reachable at all times by their customers, or who have widely varying work demands and frequent assignments to temporary locations. An AT&T study identified some of the mobile applications, and estimated their need for packet- or circuit-switched service (see Table 1).

These results support industry efforts to extend the coverage provided by wireless packet transport services. Services will be peer-to-peer and peer-to-host; using both real time and store-and-forward communications. Five basic service areas can be identified:

- *Fixed* services, such as telemetry and control applications, including meter reading, power control, etc.
- *Temporarily fixed* services, which operate in a fixed location for a period of time and then relocate. Point-of-sale and disaster-relief operations are typical.
- *Mobile* services, including tracking and information delivery services that could be used by the trucking, delivery, and security industries; and traveler information that could be provided as a part of the intelligent vehicle highway system.
- *Network extension* services that allow field sales and service personnel to have access to corporate databases and applications.
- *Executive services*, including services to the laptop, pen-based, and wireless LAN terminal market; electronic mail delivery services; and a whole raft of other personal productivity tools that can now be offered to the roaming user.

In the U.S., executive services are presently provided by AT&T EasyLink® Service, which includes AT&T Mail, AT&T Enhanced Fax, General Message Service, etc.; MCI Mail;* and CompuServe,* to name a few. These companies provide messaging and facsimile mailbox services to their users via both wired and wireless access mechanisms, while maintaining a single common user interface. These services are now being accepted by the business market, but can soon be expected to become attractive to the residential or consumer market as well. Several wireless options are supported, and users will ultimately be able to choose their favorite wireless interface (e.g. MOBITEX, cellular, CDPD, etc.) for value-added electronic mail, electronic facsimile, information, and entertainment services.

Comparison of Wired and Wireless Data Services. The introduction of wireless access to a variety of services will reshape the way these services are offered. The availability of radio spectrum and, hence, bandwidth for data services will be limiting in most cases. The physical characteristics of the radio medium will require significant protocol overhead to compensate for problems caused by multipath reception and signal fading. Existing wired transport protocols also will need to be modified to accommodate the variable length message delays that can occur due to the conditions of the wireless link. Systems with a hard handover between cellular base stations may further limit the volume of messages sent to mobile terminals in an attempt to minimize the possibility of unnecessary retransmissions.

Many existing applications will have to be redesigned to recognize these limitations. Smaller physical screens on portable terminals will limit the size and complexity of menus. Screen refresh may be done locally, instead of from the host. Files will not be broadcast, but will be selectively accepted by users when they require information. Headlines may be delivered to the user to notify them of pending messages. These are but a few of the functions that need to be carried out by an intelligent filtering agent, as mentioned earlier. Fortunately, these adaptations will not be hard to implement if we recognize them now and begin to include them in application planning.

The Role of Standards

In the wireless messaging arena, as in many others, standards play an important role. Interoperability and compatibility, based on open standards, are important for the users to accept these products and services. Indeed, conformance to industry standards gives users greater choices and reduces the eventual cost of products and services. The PCMCIA standard mentioned earlier is a good example of how standards can positively affect the wireless messaging market and, indeed, stimulate the market.

AT&T is actively working with the international community to develop data standards for wireless messaging. In the area of wireless local area networking, AT&T GIS is participating in the IEEE 802.11 working group in the U.S., and is involved in similar activities in the European Telecommunications Standards Institute (ETSI). In the cellular arena, AT&T is involved in the development of packet data standards for the analog and digital cellular environments in the U.S., while promoting an enhanced error-correcting protocol (based on CCITT V.42) for use over analog cellular circuit-switched connections. In preparation for the emerging personal communication services (PCS) market, AT&T also is working with the rest of the industry in the U.S. to develop standards for these new services.

The use of standard software protocols is seen as a tremendous plus from a service provider's and user's perspective. While the constraints of national regulations, and the differences among radio environments, are likely to result in multiple air interface standards, the use of a common set of upper-layer protocols has greatly assisted in integrating wireless messaging devices into traditional data networks. The use of standard protocol stacks has, therefore, opened up the wireless messaging world to many of the same applications that are available over fixed networks, with a minimum of modification to existing protocols. There is a need, however, to standardize even these minor modifications, and AT&T is supporting current efforts to address these issues.

AT&T and Wireless Messaging. AT&T and others are responding to the data user's need for increased mobility. From a technological perspective, low-power chip sets are being developed to support voice and data communication devices, software-definable modems will support multiple standard protocol stacks, and feature-rich personal communication platforms are evolving, like the AT&T EO 880. This, coupled with advances in the areas of PCMCIA development; satellite, cellular, and cordless technologies; LAN technologies; and data terminal

development, offer comprehensive support to this marketplace.

End-User and Equipment Vendors Perspective

From an end-user and network equipment perspective, the development of, and adherence to, industry standards for wireless messaging is strongly desired. In the U.S., there is an effort by AT&T and other vendors to develop standards for the emerging CDPD. AT&T and others also are addressing the high-volume, low-end segment of the wireless messaging marketplace with low-end, low-cost, passive radio transceivers for retail, industrial, and intelligent highway vehicle systems applications.

Service Providers Perspective. From a services perspective, AT&T is introducing "non-voice" data in conjunction with voice communications services, as well as data-only communication services for both the business and consumer markets. One example of "non-voice" data is the caller's identification being sent to a wireless device. With this feature, the information reaches the user before the actual call gets set up. This way, the end user can decide apriori how to accept the call (i.e. shunting the incoming call to a voice mailbox rather than picking up and paying the air charges). There also are several strategic initiatives underway in the areas of personal communications and multimedia, within which wireless messaging is a critical component.

Standards Perspective. Finally, from a standards perspective, AT&T continues to support open standards. It is active in both U.S. and European LAN standards activities, as well as in the U.S. cellular standards arena. This multi-pronged approach should serve our customers very well, as the wireless messaging market continues to evolve.

Conclusion

This paper has taken a look at the field of wireless messaging and has outlined some of the various technologies involved, and some of the new services that are being offered. The projected numbers of users for these services indicate how important and lucrative this field will be. There are still many challenges to overcome in the arena of standardization, reliability, portability, mobility management, and in the radio environment in general. It is these challenges, along with the promise of tremendous rewards, that make wireless messaging such an exciting field.

* MCI Mail is a registered trademark of the MCI Corporation, CompuServe is a registered trademark of CompuServe Corporation, Newton is a registered trademark of the Apple Computers, Inc., Magic Cap is a registered trademark of General Magic, Inc., Telescript is a registered trademark of General Magic, Inc., Zoomer is a registered trademark of the Tandy Corporation.

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