PUBLIC SAFETY
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WIRELESS NETWORK

*Saving Lives and Property Through Improved Interoperability*

# *Wireless Data Networking Standards Support Report: Commercial Cellular Data Services—i-mode/mMode*

**Final**

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# INTRODUCTION

Third generation (3G) wireless communication technology refers to pending improvements in wireless data and voice communications through any of a variety of proposed wireless standards. The immediate goal of 3G technology is to raise average data transmission speeds from current speeds of approximately 9.5 kilobits/second (kbps) to upwards of 2 megabits/second (mbps). This increase in data transmission rate will enable a 3G device to provide an extensive range of new functionality to mobile phone users. Until recently, mobile telephones have mainly been used for voice communications, voice messaging, as well as sending/receiving short message service (SMS) text. 3G will build on the current uses of the mobile telephone to offer simultaneous transfer of speech, data, text, pictures, audio, and video. The commercial cellular data services i-mode and mMode, both featured in this report, provide these enhanced services. Looking forward, 3G technology may revolutionize the way people use mobile devices; for example, it is envisioned that users will be able to shop online, perform online banking, or even play interactive games over the Internet using a handheld device.

The new 3G wireless systems will provide users a wireless link to a wide range of telecommunication services. Some of the key features of 3G systems include design consistency, compatibility of services, use of small wireless devices with worldwide roaming capability, Internet and other multimedia applications, and a wide range of value-added services. 3G technology, while already becoming increasingly widespread in usage and popularity in other parts of the world (e.g., Europe, Asia), is expected to reach maturity in the United States between 2003 and 2005. Some of the key service features and capabilities expected of 3G technologies are listed in Table 1.

**Table 1**
**3G Service Features and Capabilities**

| 3G Service Capabilities | Description |
|---|---|
| Circuit and packet data bit rates | • 144 kbps or higher in high mobility (vehicular) traffic<br>• 384 kbps for pedestrian traffic<br>• 2 Mbps or higher for stationary indoor traffic |
| Interoperability and roaming | • Roaming capabilities throughout Europe, Japan, and North America<br>• Compatible with most, if not all, popular communications modes (e.g., Cellular, e-mail, paging, fax, videoconferencing, and Web browsing) |
| Multimedia services and capabilities | • Fixed and variable data speeds depending on Internet traffic<br>• Bandwidth on demand<br>• Asymmetric data rates in the forward and reverse links<br>• Enhanced multimedia (e.g., Voice, data, and remote control)<br>• Broadband Internet access up to 2 Mbps |

3G wireless technology will drive the future developments in mobile communications for both the consumer and business communities. 3G is expected to offer an "always-on" connection for users in most places. With the rapid growth of subscription wireless services in the United States, Europe, and elsewhere, carriers and infrastructure providers face the challenge of addressing bandwidth concerns resulting from this growth. Bandwidth limitations, coupled with the public's desire for always-on mobile wireless data services, have driven commercial service providers to develop technology solutions. This paper highlights two unique and relatively new commercial cellular data service solutions—i-mode and mMode. This report provides a description of both i-mode and mMode, as well as an overview of the considerations for the application of these commercial wireless data services for the public safety community

## i-mode

NTT DoCoMo [i.e., NTT Mobile Communications Network Inc., a subsidiary of the Japanese telecommunications firm NTT (Nippon Telegraph and Telephone Corporation)] introduced i-mode (information mode), a wireless Web service for mobile telephones, in February 1999. Available in Japan and Hong Kong, i-mode supports wireless voice communications, Web browsing, and e-mail. With the current user base estimated at 30 million, DoCoMo's success in the mobile wireless data service market may be attributed to several factors, including: the use of packet switching technology, the high cost of Internet service in Japan, and the widely accepted use of portals. Four essential components are required for i-mode service—

- A wireless handset capable of voice and packet communication – with a browser installed
- A packet switched network, such as the Internet
- An i-mode server
- Information providers such as portal sites for CNN or Nikkei News.

Using i-mode, the subscriber can perform many tasks, including—

- **Send and receive e-mail from several sources**—automatically assigns the i-mode e-mail address and also supports external e-mail clients
- **Perform financial transactions**—supports online banking functions
- **Access Web content**—Gives users access to more than 600[1] official portal sites and more than 15,000 unofficial (i.e., personal Web sites) not listed on official guide
- **Download images, ringtones, and melodies**—supports a wide range of audio capabilities including full motion video.
- **Play interactive games**—offers a wide variety of games for multiple or single players
- **Purchase items**—allows products to be purchased from vending machines using telephones equipped with barcodes.

[1] *An official site is a feature of the i-mode "menu list." Sites not linked to this menu are considered unofficial sites.*

From its inception as a Web browsing service, i-mode has continued to develop rapidly. Java compatible i-mode applications currently enable the user to download software to mobile telephones. One such new Java compatible 3G mobile communications technology platform, Freedom of Multimedia Access (FOMA), will soon allow i-mode users to download video images and other bandwidth-intensive content with its high-speed packet data communications. Some of the new capabilities that FOMA will offer to i-mode in the future are described in Table 2.

**Table 2**
**FOMA Capabilities**

| INTERACTIVE | POINT-TO POINT | ONE WAY | MULTIPOINT |
|---|---|---|---|
| • Video Conferencing<br>• Videophone<br>• Mobile Banking | • Video mail<br>• Web<br>• E-mail | • Video catalog shopping<br>• Mobile video player<br>• Mobile audio player | • Mobile TV<br>• Advanced car navigation |

NTT DoCoMo markets FOMA as a revolutionary 3G mobile service for voice and high-speed data communications enabling users to connect with anyone anytime around the world. With a maximum downlink speed of 384 kbps (40 times faster than conventional wireless data communications), the FOMA platform will enable the delivery of high-quality video and enhanced voice clarity.

## Technology Overview

Wideband code-division multiple access (W-CDMA) serves as the foundation for NTT DoCoMo's FOMA 3G mobile communications platform. W-CDMA is a standard developed through the International Telecommunications Union (ITU), which is a standards development organization that provides the coordination for global telecommunications networks and services. The W-CDMA standard is derived from code division multiple access (CDMA). FOMA, an overlay packet network on DoCoMo's main network, supports the i-mode service. The i-mode network structure is shown in Figure 1.

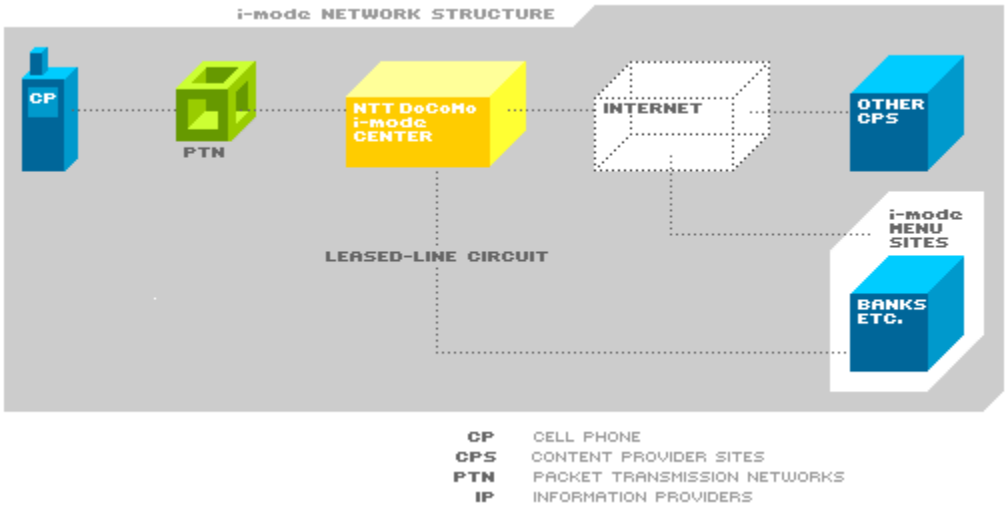


**Figure 1[2]**
**i-mode Network Structure**

The following discussion of Figure 1 describes the process of using a mobile telephone to access the Internet using the i-mode service:

1. When an action is initiated from the cellular telephone (CP), the packet is routed from the telephone through a packet transmission network (PTN), which sends the information to the NTT DoCoMo i-mode center.

2. The NTT DoCoMo i-mode center is the core network and data center. Through this Internet Protocol (IP) core/data center, the user will be able to connect to sites, run programs, receive messages, and transmit e-mails. The i-mode center transmits the information over leased lines or over the Internet itself.

3. Finally, depending on the user's need, the information is routed from the Internet or leased lines to other content provider sites (CPS) or to the i-mode menu sites where the user can perform bank transactions, read news and weather information, and purchase movie tickets.

   The i-mode service is based on several de facto Internet standards including—

   - **Graphic Interchange Format [GIF (file extension)].** Owned by Unisys, GIF is a very common file format used for graphic images.

   - **Hyper Text Markup Language (HTML).** Accepted by the World Wide Web Consortium, HTML is a group of codes or markup symbols used in files accessible on the Web. The symbols define the Web page display criteria (visual formatting) to the

2 *Source: www.nttdocomo.com/top.html*

Web browser. HTML is commonly used by Microsoft's Internet Explorer and Netscape's Communicator.

- **Hyper Text Transfer Protocol [HTTP (World Wide Web Protocol)].** This protocol defines the rules for exchanging a variety of files including text, images, sound, video, and other multimedia. HTTP is included in files that reference other files for additional transfer requests.

- **Java.** A general purpose, object-oriented, cross-platform programming language, Java was created for use on the Internet. Developed by Sun Microsystems, it can be used for a variety of functions including the development of applications, modules, or applets. Note that Java is not an acronym.

Note that i-mode is not based on the Wireless Application Protocol (WAP), which is the standard that defines the methods by which cellular telephones and other wireless devices access the Internet.

**Service Plans**

One unique aspect of i-mode is the billing process. The subscriber is not billed for the length of the connection time but for the volume of data transmitted. Similar billing plans were available when cellular digital packet data (CDPD)[3], a common data transmission platform, was introduced. However, many agencies using CDPD have formulated unlimited use agreements with CDPD providers that specify a flat rate for each subscriber unit. Many states and cooperative purchasing entities also have negotiated these more cost-effective CDPD pricing plans for government entities.

Users can stay "online" for as long as the device will allow, free of charge – provided that no data is transmitted. The service cost is dependent on how the subscriber uses i-mode and whether any fee-based services are selected. Generally, subscribers pay a monthly service charge of 300 yen (or $2.33) to access i-mode service. The subscriber pays 0.3 yen (or $0.002) for each packet of data (128 bytes) sent or received. NTT DoCoMo claims the typical subscriber pays approximately $13 US per month for packet data.

**Devices**

Thus far in 2002, the Japanese market received 69 percent of the total shipments of i-mode handsets. Often referred to as "smartphones," i-mode handset screen sizes range from 96 x 108 pixels to 120 x 130 pixels or approximately 6 and 10 lines of text, respectively. A typical i-mode telephone display is shown in Figure 2.

3 *CDPD is an open specification that supports access to the Internet and other public packet-switched networks.*

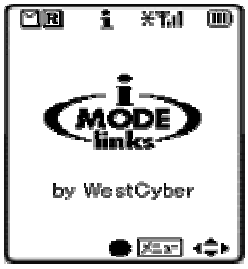


**Figure 2**
**Typical i-mode Telephone Display**

i-mode handsets function using either 256-color, monochrome, or gray displays. Most i-mode telephones transmit data at a speed of 9,600 bytes per second (Bps). Because of the 500 byte limit for Latin text e-mail and the limited amount of text data available from the i-mode Web sites, this transmit speed may be adequate for most users. A Sony SO210i i-mode handset is shown in Figure 3.

**Figure 3**
**Sony i-mode Capable Handset**

Text messaging shorthand, a combination of symbols, numbers, and letters is used regularly in Japan to maximize message content and to entertain the reader. Several vendors have issued user guides for text messaging that capture basic conversation, simple "text talk," and basic feelings. For example, the letters, "TYT" translates into the phrase "take your time" and the characters ":-@" provides a visual queue that translates into "I'm shocked." Shorthand text messaging allows i-mode users to express words, emotions, and instructions in an abbreviated form, thus reducing cost by limiting the amount of transmitted content.

## Future Outlook

Another service of NTT DoCoMo, cmode, provided in conjunction with Coca Cola Japan, will support the use of a hybrid vending machine/mobile information terminal for mobile content delivery and micro-payment services. The mobile information terminals offer more than a payment system for vending machines, these terminals issue tickets for local events and venues

and city maps. The Japanese consumer market will likely accept this new add-on service, although wide-scale implementation has not yet occurred.

Partnering with KPN Mobile N.V. and E-Plus Mobifunk GmbH & Co. KG (E-Plus), NTT DoCoMo expanded the i-mode service into Europe in March 2002. For additional information regarding this partnership or the i-mode service offering, visit www.kpnmobile.com, www.kpn.com, or www.eplus-i-mode.de.

# mMODE

As part of a multimillion-dollar advertising campaign entitled "mlife", AT&T Wireless introduced mMode to the U.S. wireless marketplace[4]. mMode is a less feature-rich version of DoCoMo's i-mode. NTT DoCoMo has invested heavily in AT&T Wireless, thus these commercial cellular data services may become more similar in the future. AT&T markets mMode as a service that can connect people with unprecedented ease and simplicity using a cellular telephone. To do this, mMode offers simple, fast access to a variety of communication, information, and entertainment services using the keypad of a wireless telephone. mMode functions include the synchronization of cell telephones to the user's desktop e-mail, contacts, and calendars, including MS Exchange, and Lotus Notes; as well as all other major messaging and personal information management (PIM) products. To become a subscriber to mMode, users must have an mMode service plan, a Global System for Mobile Communications (GSM) voice-calling plan, and a GSM/General Packet Radio Service (GPRS) compatible telephone.

Above and beyond standard Web services, several additional key mMode services are provided, including—

- **Message center**—e-mail, instant messaging, and text messages
- **Personal organizer**—calendar, address book, and a to-do list
- **Alerts**—short messages originating from the Internet that may include traffic, financial, and sports-related alerts
- **Content**—search capabilities that include entertainment, yellow and white pages, stock quotes and the latest financial news, news, entertainment, and travel
- **Games**—interactive games originating from the Internet, including multi-player options.

## Technology Overview

AT&T is in the process of upgrading its time division multiple access (TDMA) network to GSM, a wireless digital standard used throughout the world. AT&T expects to complete the migration to GSM by year's end. GPRS, which is based on GSM, is a platform used to transfer data across the mobile telephone network and is used by AT&T to support the mMode service. For additional information regarding GPRS, visit the Public Safety Wireless Network Program Web site at www.pswn.gov and look for the section titled Wireless Data Topics Reports.

## Devices

To access the mMode service, a GSM/GPRS compatible telephone is necessary. These telephones are often referred to as "smartphones" because they offer dual functionality—voice

[4] *This recently deployed commercial data service is only obtainable in select AT&T Wireless GSM markets. As a result, information is not yet readily available. However, general cost estimates are provided.*

and data. One such example, the Sony Ericsson T68, shown in Figure 4, is configured with 16 buttons, a joystick, and a side key. This telephone operates using a WAP 2.0 Browser, which supports HTML Web sites and a built-in e-mail client. Depending on available memory, this telephone can store more than 20 color photographs, and an unlimited number of ring tones and images. Voice memo is another interesting feature which affords the user the ability to record a memo directly into the telephone. The number of display lines depends on the font of the text. Various wallpaper selections (i.e., background shown on the screen) and photographs can also be stored and displayed.


**Figure 4**
**Sony Ericsson T68**

The telephones currently offered, including the Sony Ericsson T68 shown above, cost approximately $200. In mid-2002, AT&T plans to offer a cellular telephone that can search portals[5] and traditional Web sites.

### Service Plans

The current subscriber fee for mMode is $2.99 per month plus 2 cents pre kilobyte (Kb) of data downloaded, which equals approximately $20.00 per megabyte (MB). Users can also purchase 1MB for $7.99 or 2 MB for $12.49 based on the amount of data they expect to use. The different mMode service plans, as shown in Table 3[6], include Mini, Mega, or Max packages, each of which is available for a monthly fee plus usage charges. Each user incurs charges based on kilobytes of information transmitted; as a result, depending on the application type, charges will vary.

**Table 3**
**mMode Service Plans**

| | Mini | Mega | Max |
|---|---|---|---|
| Monthly service charge | $2.99 | $7.99 | $12.49 |
| MB included | 0 | 1 | 2 |
| Out-of-plan charge (additional data per kilobyte in home coverage area) | $0.02 | $0.01 | $0.01 |

Additional data usages charges are calculated based on kilobytes consumed.
1 MB = 1,024 Kb

[5] *Portal is a generic term used to describe an entry point to the Web.*

[6] *Price listing can be found at AT&T' s mMode site at www.attws.com/press/release/2002_04/041602.html*

As shown in Table 3, if a user purchases the Mini service plan, no bytes of data are included. The user will be charged the monthly fee plus $0.02 for each kilobyte of data consumed. Conversely, if the user purchases the Mega or Max plan, 1 or 2 MB of data, respectively, will be included in the billing plan with a charge of $0.01 for any additional kilobytes of data consumed.

**Future Outlook**

In the near future, mMode will be enhanced with an expanded selection of commercial e-mail and instant messaging services, more content choices, and a set of sophisticated services including digital photographic messaging. Presently, approximately 150 content providers, including news providers, location services, and commercial airlines, are developing products for mMode. By the end of 2002, AT&T hopes that the total number of content providers will reach between 400 and 600.

# PUBLIC SAFETY CONSIDERATIONS

Until recently, mobile telephones were used mostly for sending and receiving voice calls. Today, commercial cellular data services provide voice transmission quality on par with fixed line communications, with minimal interference and noise, while supporting diverse multimedia content. Potentially, cellular data services (e.g., i-mode, mMode) may be suitable for use within certain segments of the public safety community. These services, coupled with a ruggedized handheld device, could reduce the number of communications devices carried by most responders. In addition, the service's always-on connectivity could enable responders to place voice calls, send and receive text messages, receive photographs or "mug shots", and search intra- and inter-agency databases in real time with greater mobility than is currently possible. However, public safety officials examining the potential application of this technology should consider the following—

- **Handheld Device Operation and Functionality May Not Be Suitable for Public Safety Applications.** Public safety agencies that are considering the potential use of these new generation data devices must analyze the ergonomic impact of the device on the agency's mission. Many of these new devices provide a compact footprint and innovative features, but it is of paramount importance that the devices be appropriately matched to the harsh environment in which they may be used. If the devices are to be used in the "mainstream" day-to-day efforts of law enforcement, fire and emergency medical services agencies, they must be easy to read and manipulate with bare fingers and gloved hands. Navigation of the features and services supported by the devices should require a limited number of keystrokes. The device should be robust enough to withstand the harsh environmental conditions and rough treatment normally found in the public safety environment.

- **There is a Lack of Adequate Security Provisions.** Although these services offer multiple communications capabilities, at present, no commercial off-the-shelf applications meet the security demands of the public safety community. Voice and data encryption, as well as voice and data privacy, are not part of the standard service. Public safety officials considering the use of these services should also examine the viability of third-party security or encryption products for these next generation services. These add-on products and the security of the data traversing the network must meet stringent state and federal regulations applicable to criminal justice information.

- **Priority Access and Restoration Agreements Are Necessary.** Similar to cellular voice requirements for public safety, priority access to network infrastructure will be necessary for the day-to-day use of commercial cellular data service. In addition, it is important that agencies using commercial services for critical communications ensure that they have specific agreements regarding continuity of services and services restoration subsequent to a major incident or event. Public safety officials should negotiate these important points as the fundamental baseline of access agreements for any commercial data services.

- **Service Is Not Proven.** Commercial cellular data services, such as mMode, are relatively new in the United States and have not gained widespread public appeal, usage, or acceptance. Generally, the majority of the limitations and shortfalls have not been identified or completely researched by vendors. Further, the service has not yet been "tested" by the general public or the public safety community.

- **Cost Effective Plans Are Not Available.** Throughout a normal work day, public safety users routinely request information from National Law Enforcement Telecommunications System (NLETS), National Crime Information Center (NCIC), state and local criminal databases, drivers license databases, and vehicle information databases. These criminal justice system inquiries, coupled with information from computer-aided dispatch (CAD) systems and local Records Management Systems (RMS), may potentially generate a tremendous amount of data traversing a commercial network. Many of the criminal justice systems across the Nation have a variety of different inquiry routines that will produce various responses. In many of these systems, it is possible to make a single inquiry that results in multiple searches against multiple local, state, and national systems, each providing a positive or negative response transaction.

  According to cursory information gathered from law enforcement agencies that currently use wireless data systems, an average of three inquiries are generated by field resources each hour. This does not include other wireless data traffic such as CAD incident messages, routine messaging between units and fixed points, or other inquiries and responses to other available systems. Based on the user payloads of the transactions shown in Table 4, the use of these commercial cellular data services under a "per kilobyte plan" would likely be cost prohibitive and preclude most public safety agencies' use of this service.

**Table 4**
**Common Public Safety Transactions and User Payloads**

| Transaction Types | User Data Payload (Bytes) |
|---|---|
| Vehicle Inquiry | 64 |
| Persons Inquiry | 100 |
| Regional System Positive Response | 1250 |
| Stolen Vehicle Negative Response | 222 |
| State System Positive Response | 550 |
| State System Negative Response | 210 |
| NCIC System Positive Response | 750 |
| NCIC System Negative Response | 170 |
| NLETS Positive Response | 750 |
| NLETS Negative Response | 170 |
| State Department of Motor Vehicles Response (Plate Response) | 1250 |
| State Department of Motor Vehicles (Drivers License Response) | 1550 |

# FUTURE OUTLOOK

There are many barriers to the wide-scale use of these new commercial cellular data services by public safety users in the United States, including lack of attractive pricing plans, lack of interoperability standards, and limited market penetration. Because the user is charged by the kilobyte, text messaging may prove too costly for the average consumer and certainly for most public safety applications. Furthermore, commercial providers have not yet adopted a common standard for the use of data services across disparate providers or adequate interconnections between various systems. As a result, communications among friends, family, and co-workers could be hindered. As these " next generation" wireless services continue to mature and expand, there may be new opportunities for use in the public safety arena. In the near term, these services may be beneficial for a select group of public safety executives who may have less voluminous data requirements. However, it should be noted that many of the technologies adopted by public safety agencies were originally commercial services offerings that were modified, enhanced, and attractively priced for public safety use.