New Technology Report

Special Article on IMT-2000 Services (1)
– Launch of FOMA, the Pioneer of the New Mobile Age –

Services and Terminals

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This article reviews the development concept for the network services, applications and mobile terminals of FOMA, the IMT-2000 service, and the characteristics of typical services.

1. Introduction

In second-generation mobile systems, Personal Digital Cellular (PDC) and PDC mobile Packet data communication System (PDC-P), services and applications were based primarily on speech telephony such as answering machine functions, and primal data services were text-based on i-mode. The introduction of International Mobile Telecommunications-2000 (IMT-2000) services, which enables high-speed data communications, can even deal with larger contents like multimedia information.

DoCoMo has rolled out its IMT-2000 service (service name: FOMA★1) based on the idea that the service in the introductory stages must make the characteristics of IMT-2000 appear highly attractive, in order to facilitate its market penetration and expansion. Specifically, network services include Short Message Service (SMS) and multi-access, whereas applications include i-mode on IMT-2000 that harnesses high-speed transmission to transfer large contents, in addition to video streaming, video telephone and other visual communication services. DoCoMo has been planning and developing mobile terminals (FOMA terminals) to achieve such services based on new concepts, in order to deal with multimedia contents that are large in data volume.

This article reviews such key services, applications and FOMA terminals.

2. Network Services

2.1 Introduction of Network Services

IMT-2000 network services, which target global services, basically need to be implemented based on specifications in

★1 FOMA: The brand name of DoCoMo's third-generation mobile communications system (IMT-2000). The abbreviation of Freedom Of Mobile multimedia Access.

Table 1 SMS Service Overview

Maximum Number of Characters	Up to 70 characters in UCS-2 code. Up to 160 characters in Default alphabet code.
Validity-Period in MPS	Can be set between 0-3 days by short-message sender. (Can be set separately for each short message.)
Status report to originating mobile phone	A function to notify the sender as to whether the short message has reached the destination. Can be set by the short-message sender. (Can be set separately for each short message.)
Timing of Short Message Reception and Retransmission by MPS Opportunity	Upon the arrival of a new short message Upon transmission/reception of voice call. Upon location registration Upon attachment Upon voluntarily acquiring a short message by selecting one of the menu options in the mobile phone

MPS: Message Processing System
UCS: Universal multiple-octet coded Character Set

compliance with standards.

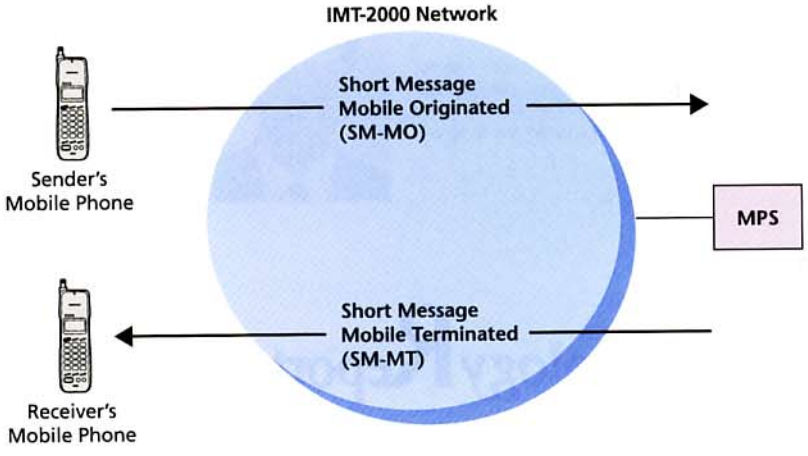
However, the standard specifications of IMT-2000 (3GPP: 3rd Generation Partnership Project) are based on the Global System for Mobile communications (GSM), which are different from DoCoMo's PDC and PDC-P. This raises the need to consider the user-friendliness of specifications to existing users.

Hence, DoCoMo decided to introduce its proprietary network services in the development stage of FOMA in the following categories:

(1) PDC services that are heavily used by users
e.g. Answering machine service, call forwarding service

(2) Services that are socially necessary
e.g. Nuisance call blocking service, drive mode

(3) Services that draw attention to IMT-2000's characteristics
e.g. SMS, multi-access service



IMT-2000: International Mobile Telecommunications-2000
MPS: Message Processing System
SM-MO: Short Message Mobile Originated point-to-point
SM-MT: Short Message Mobile Terminated point-to-point

Figure 1 Basic SMS Functions

2.2 Typical Network Services

(1) SMS

① Service Overview

SMS provides a means to transfer short messages between next-generation mobile phones (**Table 1**). The function of SMS is based on GSM standards.

② Overview of Basic Functions

Short messages are transferred via a server. The mobile phone has two functions: to send short messages to the Message Processing System (MPS), which is a server; and to receive short messages from MPS. Each function is described below. **Figure 1** illustrates the configuration of SMS.

- Short Message Mobile Originated point-to-point (SM-MO): This function provides the transmission of a short message from a mobile phone to MPS.
- Short Message Mobile Terminated point-to-point (SM-MT): This function provides the transmission of a short message from MPS to a mobile phone.
- MPS: Function responsible for the relaying and store-and-forwarding a short message between mobile phones.

(2) Multi-access

① Service Overview

Multi-access is one of the distinctive services offered by

FOMA. This service enables the simultaneous transmission of a circuit-switching call and a packet switching session to make communications more flexible. It is aimed at improving user-friendliness and expanding the field in which mobile communications can be used.

With this service, users can search information using the browser on the i-mode mobile phone or exchange e-mails from PCs during a speech call.

② Key Requirements

As a basic function, the service can communicate a circuit-switching call (speech) and a packet-switching session simultaneously with each of their own connection (**Figure 2**).

③ Overview of Basic Functions

During such simultaneous communication, each call is controlled independently of each other. The call can be established and released at the same time for each destination.

During the speech communication, the user can send and receive packet data by operating the from mobile phone or PC. During the packet communication, the user can also originate and terminate speech call by operating from the mobile phone. Depending on how the user presets and operates their mobile phone, it can be connected to the voice mail center, or to the call forwarding service. This operation can also be done simultaneously when the user recieves a call.

3. Application

3.1 i-mode

(1) Service Concept

DoCoMo will evolve i-mode service furthermore by adding new functions to make the service more attractive, while keeping its user-friendliness. It is a distinctive result of harnessing the large-capacity, high-speed communication capabilities of IMT-2000.

(2) Features of i-mode

The primal characteristics of FOMA i-mode inherits the usability of current i-mode and at the same time, it enables the distribution of large-sized contents through high-speed packet transmission, up to 384kbit/s downlink.

For i-mode mail, the capacity of each message is increased from the current 250 characters to 5,000 characters. With attachments, the size is expanded from 500 Bytes to 10,000 Bytes. In addition, GIF (Graphic Interchange Format), JPEG (Joint Photographic Experts Group) and SMF (Standard MIDI File) are newly supported as a format of attached files, to provide a diverse multimedia service which is not limited to text-based communications.

For web browsing, FOMA i-mode supports Java★2 and SSL★3 as a standard feature, can present many kinds of file formats (JPEG, SMF) and has larger capacity for i-appli, which enables users to download more various advanced applications, and to enjoy a wider range of contents, including dynamic contents.

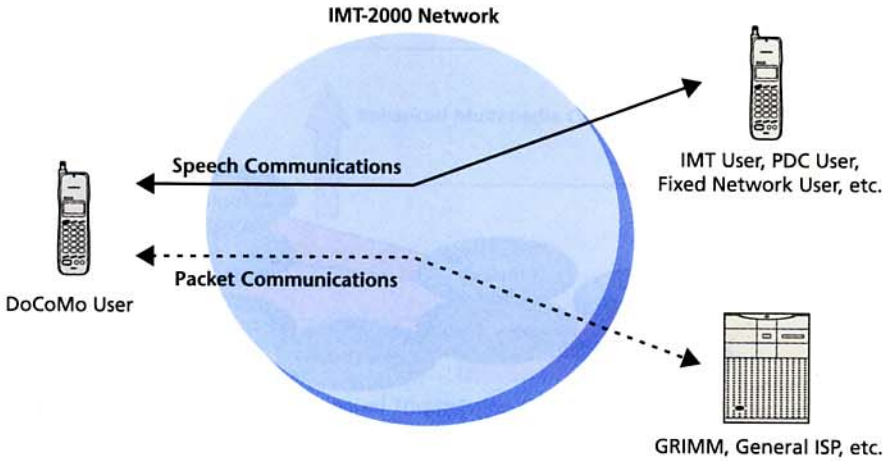
In addition, the multi-access function creates a new communication style: users can engage in speech communication and use i-mode simultaneously.

(3) Service Expansion

FOMA i-mode, which is enhanced by new functions without losing accessibility and convenience of i-mode, is expected to progress further to deliver more attractive contents to users. For example, DoCoMo is planning to apply MPEG (Moving Picture Experts Group)-4 for downloading video clips. This makes it possible for users to enjoy clips of crucial moments in the news, promotion videos of movies and other video materials. Further

★2 Java: An object-oriented programming language suited for use on networks, developed and advocated by Sun Microsystems in the U.S.

★3 SSL: Secure Sockets Layer, a protocol that creates a secure connection between a client and a server, developed and advocated by Netscape Communications in the U.S.



GRIMM: Gateway service Representative Internet Market Mobile access exchange
IMT-2000: International Mobile Telecommunications-2000
ISP: Internet Service Provider
PDC: Personal Digital Cellular

Figure 2 Basic Multi-access Functions

enhancements in multimedia services are planned ahead, to make more attractive contents available to users (**Figure 3**). DoCoMo will roll out more accessible, convenient i-mode service by adding communications with Point Of Sales (POS) registers, multimedia kiosk terminals and other external devices.

After the launching of packet roaming services, users will be able to use i-mode terminals overseas: they will be able to access contents to which they usually access in Japan, as well as useful information in the local area. This means that the i-mode service will be more widely available everywhere.

3.2 Video Distribution and Video Telephone

M-stage visual and video telephones will be in charge of building the visual communication market based on IMT-2000.

(1) M-stage visual (Video Distribution Service)

M-stage visual, which is based on the "entertainment on your palm" concept, is a video distribution service that enables users to watch videos on demand anywhere, anytime. In FOMA, users access the service from a single entrance: the i-mode portal, which accommodates the M-stage visual portal. The M-stage visual portal effectively uses icons and pictures to hammer out the characteristics of video, and is designed under the policy to offer visual enjoyment to users in the process of choosing contents.

The contents line-up is led by movie trailers, information on video programs and other entertainment contents, followed by news, sports, daily tips, shopping, and other useful infotainment contents covering a wide range fields, which have been further enhanced for FOMA users.

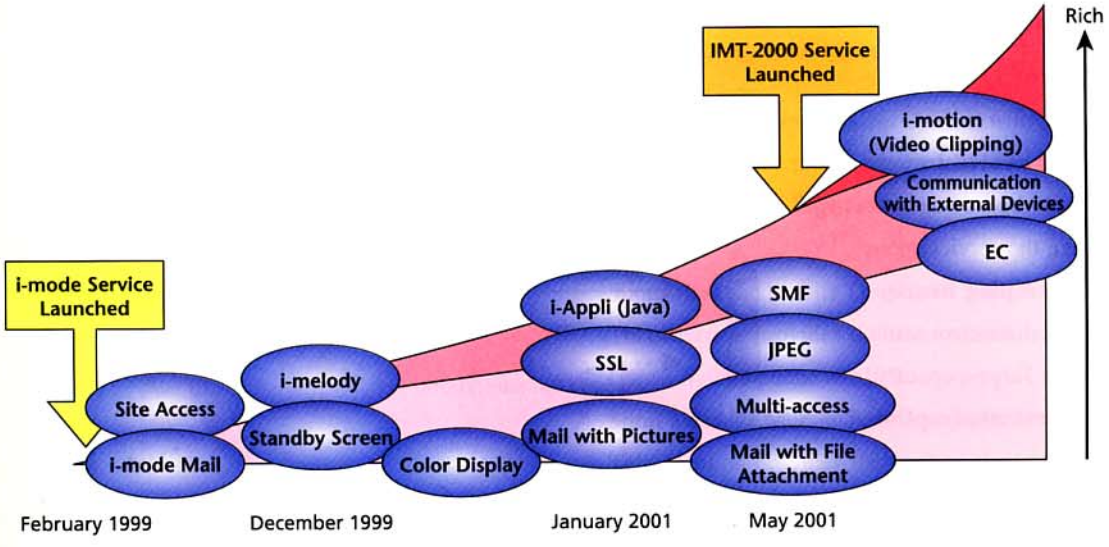
DoCoMo is also showing the procedures to develop contents and introducing tools for mobile Advanced Streaming Format (ASF; header information attached to ASF for mobile), so that users can apply video information in business and citizens in general can provide contents as well.

Contents distribution is based on circuit switching, and information is offered in two formats: streaming and downloading. Video compression technology adopted by FOMA is the international standard MPEG-4. In the future, DoCoMo intends to convert the protocol inside the network (using the video-telephone protocol 3G324M), further improvements in picture quality and not only supporting ASF file format but as well as using together with the future standard MP4, and also offering original services of FOMA.

(2) Video Telephone

Video telephone is a flagship service of visual communications, which enables users to engage in an interactive dialogue whilst seeing each other on real-time video. It is expected to be used not only in conversations between individuals, but also in customer services by companies, construction site monitoring, and many other business areas. The service is likely to spread rapidly in the years to come.

DoCoMo is also working on interconnecting the video tele-



EC: Electronic Commerce
IMT-2000: International Mobile Telecommunications-2000
JPEG: Joint Photographic Experts Group
SMF: Standard MIDI (Musical Instrument Data Interface) File
SSL: Secure Sockets Layer

Figure 3 i-mode Development Strategies

phones with NTT's video telephone Phoenix mini, to promote the market penetration and expansion of video telephones on a full scale.

(3) Others

DoCoMo is also planning to offer a video mail service based on Web mail. This is expected to generate applications that are different from real-time video telephone. As conventional i-mode mail evolved from a pager-based message exchange to a short message service, DoCoMo aims to implement a new mail service through video.

4. FOMA Terminals

4.1 Implementation of FOMA Terminals

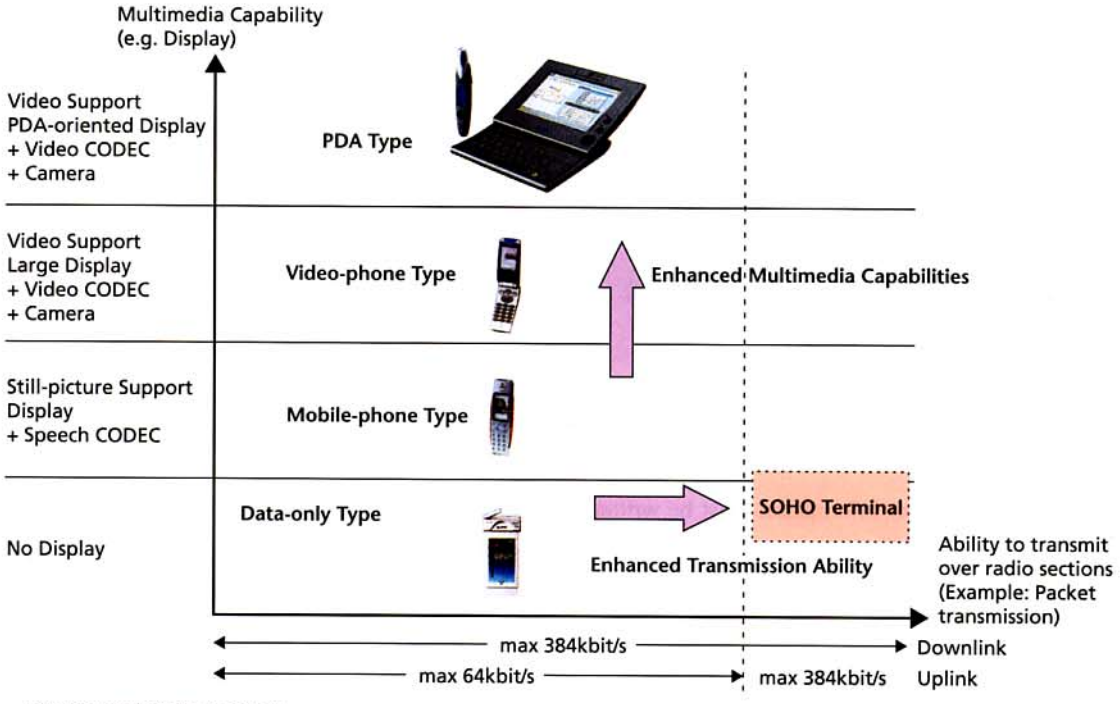
Third-generation mobile terminals are wide in variety, ranging from mobile-phone types, PC-card types dedicated to data communications; video-phone types that can display video, to Personal Digital Assistant (PDA) types that are combined with PDA. Whilst these variations can be categorized by the combination of their abilities, notable characteristics of third-generation mobile terminals include the hardware multimedia capabilities (e.g. display), the ability to transmit over radio sections, and the ability to carry various types of multimedia applications.

For example, **Figure 4** maps the terminals' ability to transmit over radio sections on the horizontal axis and their hardware multimedia capabilities (e.g. display) on the vertical axis.

What makes the third-generation terminals distinctive more than anything else is its high-speed transmission ability. However, there is a trade off between speed (which stresses the hardware such as memory and processing power) and size and portability. With Wideband Code Division Multiple Access (W-CDMA), many mobile-phone types are expected to achieve speed up to 384kbit/s, as it is easy to achieve 384kbit/s packet transmission due to the fact that increases in downlink speed have a relatively small impact on hardware, thanks to wideband transmission. In environments where faster upstream transmission is required, variations like SOHO terminals are expected to appear: such as terminals connected with a server, and multiple computers connected to each other in a Local Area Network (LAN) which are often used in the SOHO environment.

Figure 5 maps the installed applications on the horizontal axis and the multimedia capability on the vertical axis. Even if the terminal's hardware multimedia capability (e.g. display) is high-leveled, it's full abilities are not useful without applications services that provide a wide range of contents. In particular, to receive the advanced services such as video distributions, video-phones and PDA types which has multiple applications requires not only a large display but also substantial abilities in memory and processing power.

Photo 1 shows FOMA terminals that were released in the spring of 2001.



PDA: Personal Digital Assistant

Figure 4 Example of Correlation between Multimedia Capabilities and Radio Transmission Ability

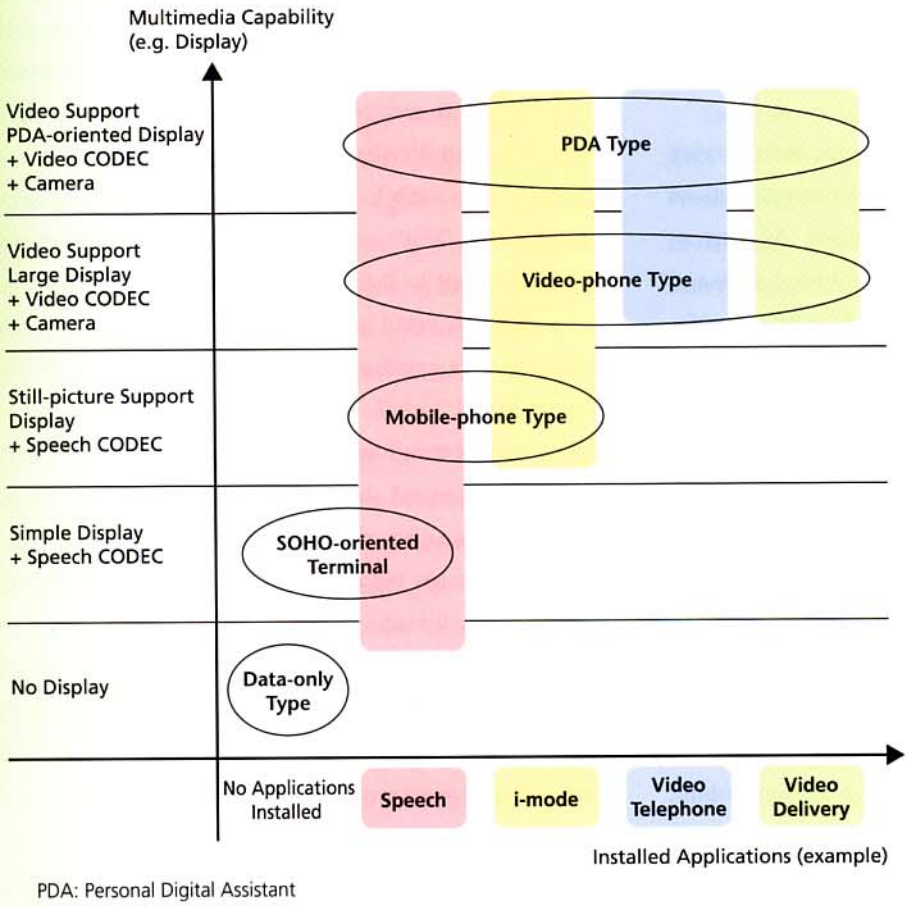


Figure 5 Example of Correlation between Multimedia Capabilities and Installed Applications

Photo 1 FOMA Terminals

4.2 UIM

In cellular systems, subscriber information must be written in the mobile phone so that the phone can be identified to control recieving calls and charge communication fees. The International Telecommunication Union-Telecommunication standardization sector (ITU-T) refers to the media which memorizes the subscriber information as the User Identity Module (UIM) in its recommendations for IMT-2000 systems. UIM is an IC-card with an inbuilt Central Processing Unit (CPU). Two types are available: one in the size of a credit card in general; and the other in a plug-in size, which consists only of a terminal strip for miniaturization purposes. UIM has already been introduced in GSM systems, which are widely used in Europe, where it is called Subscriber Identity Module (SIM).

In conventional cellular systems commercialized in Japan, subscriber information is stored in the non-volatile memory of the mobile phone itself, excepting some car phones. In such systems, a special device is required to write/erase subscriber information.

There are two merits of introducing UIM, one is that the mobile phones can be easily swapped, and the other is the security improvement. If subscriber information is written in the mobile phone itself, the user cannot substitute the phone in the event of malfunctioning until his/her subscriber information is rewritten on the alternative phone with a special writing device. In contrast, UIM allows users to swap mobile phones whenever they are necessary, simply by reinserting the card. This merit is appreciated not only in the event of malfunction, but also by subscribers who have more than one mobile terminal (owners of a small mobile phone, inbuilt PDA phone, etc.), as it enables them to swap their terminals in a flexible manner. IC cards are structurally robust against electric and mechanical attacks aimed at undermining security (i.e., they are strong against tampering), and require the user to enter a Personal Identification Number (PIN), which is a type of password, for accessing and rewriting any memorized data. Security is maintained at an extremely high level by these two features.

In addition to subscriber information, UIM stores the user's phone number, phonebook, SMS, total call charges, etc. Another important function of UIM is the authentication function. Conventional mobile phones have an inbuilt authentication function, to prove that the user is an authorized subscriber in

Photo 2 FOMA Card

response to the network's request. UIM is equipped with a similar function, to check that the authentication request is coming from an authorized network, which enables the terminal and the network to confirm each other's authenticity (mutual authentication function). **Photo 2** shows a UIM in FOMA (FOMA Card).

5. Conclusion

This article reviewed IMT-2000 services, and distinguishable services, applications, and mobile terminals in FOMA. DoCoMo will roll out mobile multimedia based on these developments in the future.

GLOSSARY

3GPP: 3rd Generation Partnership Project
ASF: Advanced Streaming Format
CPU: Central Processing Unit
EC: Electronic Commerce
FOMA: Freedom Of Mobile multimedia Access
GIF: Graphic Interchange Format
GRIMM: Gateway service Representative Internet Market Mobile access exchange
GSM: Global System for Mobile communications
IMT-2000: International Mobile Telecommunications-2000
ISP: Internet Service Provider
ITU: International Telecommunication Union
JPEG: Joint Photographic Experts Group
LAN: Local Area Network
MPEG: Moving Picture Experts Group
MPS: Message Processing System
PDA: Personal Digital Assistant
PDC: Personal Digital Cellular
PDC-P: PDC mobile Packet data communication system
PIN: Personal Identity Number
POS: Point Of Sales
SIM: Subscriber Identity Module
SMF: Standard MIDI (Musical Instrument Data Interface) File
SM-MO: Short Message Mobile Originated point-to-point
SM-MT: Short Message Mobile Terminated point-to-point
SMS: Short Massage Service
SSL: Secure Sockets Layer
UCS: Universal multiple-octet coded Character Set
UIM: User Identity Module
W-CDMA: Wideband Code Division Multiple Access