

Special Articles on Technology Supporting Large-capacity and High-efficiency Communication in the Flat-rate Era

# Data-communications Terminals with Downlink Speeds up to 7.2 Mbit/s to Meet the Increasing Demand for High-speed Data Communications

*The FOMA A2502 HIGH-SPEED and FOMA N2502 HIGH-SPEED data-communications terminals, supporting downlink speeds up to 7.2 Mbit/s, were developed to meet a variety of user needs.*

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## 1. Introduction

In recent years, with the increase in ways to use the Internet in daily life and the spread of broadband wired networks, users around the world have access to easy-to-use, high-speed data communications, whether at home or in the office. This has led to a rapidly increasing demand, from users in Japan and many other countries, for mobile high-speed data communications on their notebook PCs and Personal Digital Assistants (PDAs)<sup>†1</sup> while away from home or office.

In the past, NTT DOCOMO has developed and provided various data-communications terminals for mobile users. Personal Digital Cellular (PDC) [1] technology achieved data downlink

speeds up to 9.6 kbit/s and Personal Handyphone System (PHS) [2] provided up to 64 kbit/s communications. With the transition to FOMA, the P2401, F2402, P2402 and P2403 FOMA terminals achieved downlink speeds up to 384 kbit/s. The FOMA M2501 HIGH-SPEED introduced support for High Speed Downlink Packet Access (HSDPA)<sup>\*2</sup>[3], yielding downlink speeds up to 3.6 Mbit/s and making real, high-speed mobile communications possible. Furthermore, this service is not limited to the already-wide FOMA area; its range expanded from Japan to the whole world through its support of international roaming. All these developments have contributed to increasing user satisfaction with data services. **Figure 1** shows some of these

trends in data-communications terminals.

In addition to the issues of communications speed and coverage area, as mentioned above, issues of cost are also important from the user's perspective. Other mobile service providers in Japan are offering flat-rate data services using PHS and W-CDMA technology, and there is a wide range of products being offered packaged with mobile data-communications services. NTT DOCOMO has also begun offering flat-rate services in FOMA as of October 2007, with the "Flat-Rate Plan HIGH-SPEED"<sup>\*3</sup> and "Flat-Rate Plan 64k"<sup>\*4</sup> plans. This has involved not only offering the new rate plans, but also required expanding the range of available high-speed data-communications

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\*1 **PDA**: A personal information terminal with features like LCD screen and external interfaces.

\*2 **HSDPA**: A high speed downlink packet transmission technology based on W-CDMA and standardized by 3GPP. It optimizes the modu-

lation method and coding rate according to reception conditions at the mobile terminal.

terminals which support HSDPA. This was necessary to deal effectively with increased demand for high-speed data traffic expected due to use of “Flat-Rate Plan HIGH-SPEED”.

We have also developed the new FOMA A2502 HIGH-SPEED and FOMA N2502 HIGH-SPEED terminals, to satisfy current users’ needs and to increase competitiveness with other mobile service providers. These terminals increase the maximum downlink speeds from 3.6 Mbit/s to maximum 7.2 Mbit/s<sup>\*5</sup>, as well as expanding their range to a global scale by supporting international roaming.

This article describes various features and a performance evaluation of the new 7.2 Mbit/s data-communications terminals.

## 2. Overview of the 7.2 Mbit/s Data-communications Terminals

A comparison of the basic specifications of the FOMA A2502 HIGH-SPEED, and FOMA N2502 HIGH-SPEED 7.2 Mbit/s data terminals is shown in **Table 1**, and photographs are shown in **Photo 1**.

The 7.2 Mbit/s terminals provide multiple interface formats. The FOMA A2502 HIGH-SPEED is equipped with a Universal Serial Bus (USB) interface<sup>\*6</sup>; the most general interface currently used with PCs. It was the first product model designed in collaboration with the Korean mobile-

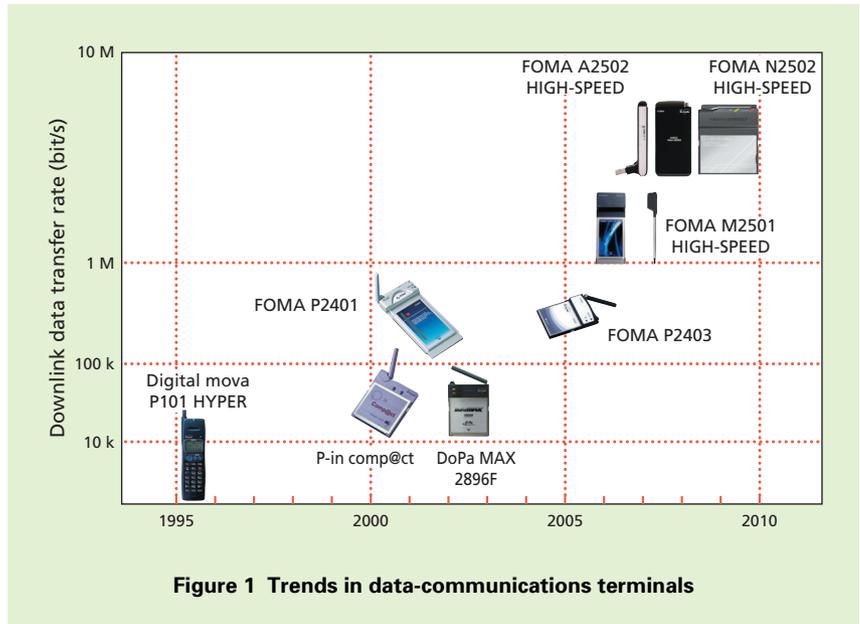


Figure 1 Trends in data-communications terminals

Table 1 Basic specifications for the 7.2 Mbit/s data-communications terminals

		FOMA A2502	FOMA N2502	FOMA M2501 (reference)	FOMA P2403 (reference)
Interface		USB	CF Type II	PCMCIA Type II	CF Type II
Size (mm)		79×37×16.4	65×42.8×8.7	130×54×18	65×42.8×9.5
Weight (g)		44	24	70	25
Frequency band	W-CDMA	2 GHz/800 MHz	2 GHz/800 MHz	2 GHz/800 MHz	2 GHz/800 MHz
	GSM/GPRS	—	—	900/1,800/1,900 MHz	—
Data-transfer rate (best effort)	Uplink (transmitting)	384 kbit/s	384 kbit/s	384 kbit/s	64 kbit/s
	Downlink (receiving)	7.2 Mbit/s HSDPA support	7.2 Mbit/s HSDPA support	3.6 Mbit/s HSDPA support	384 kbit/s
Videophone		×	○	○	○
SMS		○	×	×	×
International roaming	W-CDMA	○	×	○	×
	GSM/GPRS	×	×	○	×
Supported OS	Windows®* 2000	○	○	○	○
	Windows XP	○	○	○	○
	Windows Vista	○	○	○	○
	Windows CE	×	○	×	○
	Mac OS X	(planned)	×	×	×

\*Windows® is a registered trademark of Microsoft Corporation in the USA and other countries.

GPRS: General Packet Radio Service

GSM: Global System for Mobile communications

communications provider, KT Freetel Co. Ltd., and supports international roaming in regions with W-CDMA.

The FOMA N2502 HIGH-SPEED is equipped with a CompactFlash (CF)

Card interface<sup>\*7</sup>, which is used in many PDAs. It can also be combined with a PC Card adaptor and used on PCs with a PCMCIA Card interface<sup>\*8</sup>. This product is the successor to the FOMA

\*3 **Flat-Rate Data Plan HIGH-SPEED:** A flat-rate plan for FOMA data communications for using the Web and e-mail from a PC. Provides downlink speeds up to 7.2 Mbit/s on a best-effort basis (see \*5).  
 \*4 **Flat-Rate Data Plan 64k:** A flat-rate plan

for FOMA data communications for using the Web and e-mail from a PC. Provides downlink speeds up to 64 kbit/s on a best-effort basis.

\*5 **Maximum 7.2 Mbit/s:** Provided on a “best-effort” basis. Indicates maximum theoretical downlink (receive rate) based on technical

specifications, not actual communications rates.

\*6 **USB interface:** An interface for connecting PCs with peripheral devices specified by the USB Implementers Forum.

\*7 **CF Card interface:** An interface for memory cards specified by the CompactFlash Association.

P2403, which also has a CF Card interface, and meets customers' continuing need for communications on devices like PDAs where this interface is common. Videophone calls can also be made with this product using a camera and specialty software.

### 3. Utility Software

Unlike handset-style mobile terminals, which are equipped with keyboard and screen, data-communications terminals do not have their own user interface, so they require application software (hereinafter referred to as "utility software") running on the PC in order to perform operations like packet communications.

Using this utility software, users can easily open and close packet connections, set packet connections, send/receive Short Messaging Service (SMS)<sup>\*9</sup> and create new SMS messages and perform other operations through the 7.2 Mbit/s data-communications terminals. The utility software for each 7.2 Mbit/s data terminal has been individually designed for simple operation and excellent usability (**Photo 2**).

### 4. Functionality Evaluation

We performed an evaluation of the major functional aspects of the radio characteristics, hardware and utility software for the 7.2 Mbit/s data-communications terminals.

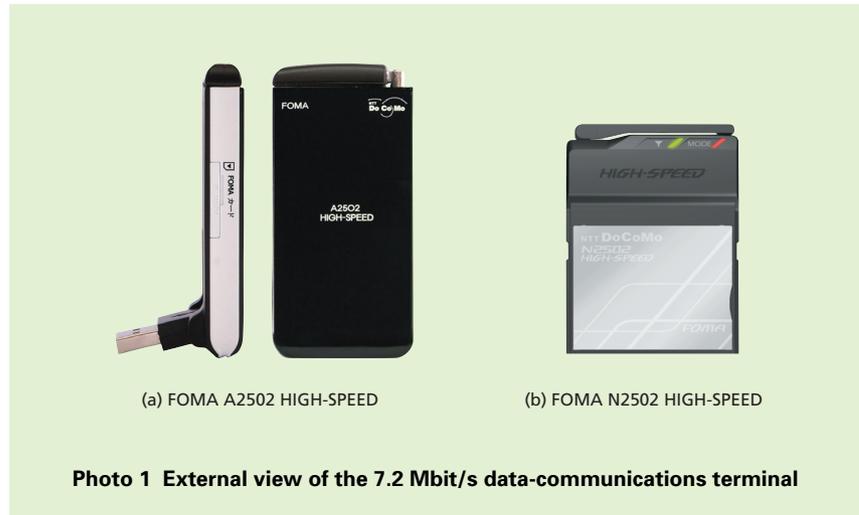


Photo 1 External view of the 7.2 Mbit/s data-communications terminal



Photo 2 Utility software screen shot

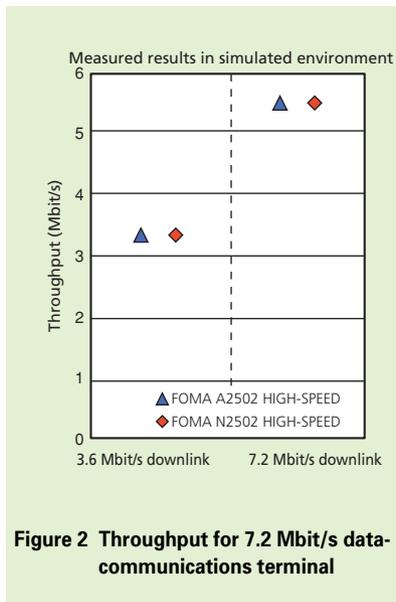
#### 4.1 Radio Characteristics

The terminals were developed before there was a network supporting these speeds available, so most of the development for 7.2 Mbit/s communications was done and evaluated using a simulated environment. To achieve the best-possible reception characteristics, we minimized throughput degradation due to poor radio environment area by using diversity antennas and also

adjusted communications parameters based on data from a variety of PCs to eliminate effects of noise on the communications terminal from the PC. In addition to the basic radio functionality, these 7.2 Mbit/s data-communications terminals were developed with a focus on data throughput. Throughput data for the 7.2 Mbit/s data terminals in the simulated environment is shown in **Figure 2**.

\*8 **PCMCIA Card interface**: An interface conforming to the PC Card standard, specified by the Personal Computer Memory Card Interface Association.

\*9 **SMS**: A service for sending/receiving short text-based messages mainly between mobile terminals.



**Figure 2** Throughput for 7.2 Mbit/s data-communications terminal

Note that actual throughput is adversely affected by factors like radio environment, number of simultaneous connected users, network parameter settings and optimization and the PC-driver configuration for the data terminal.

We also did in-the-field development focused on packet connectivity and throughput in regions supporting international roaming to ensure the quality of the wireless functionality.

#### 4.2 Hardware

We also developed the connectivity from a hardware perspective, actually connecting the 7.2 Mbit/s data terminals with PCs, and examining any effects on the PC interface connector or conversely, on the data-terminal con-

necter. As there are so many PCs on the market that can connect to these devices, we spent a lot of time performing these evaluations. We not only checked connectivity with each PC, but also set strict criteria for evaluating whether the design took into consideration the specifications and characteristics of the interface for a 7.2 Mbit/s data terminal. Through these evaluations, we have ensured the quality of the terminals with respect to PC-connective compatibility.

#### 4.3 Utility Software

The utility software is the only user interface to the data terminal, and is very closely related to the firmware of the 7.2 Mbit/s data terminal and the drivers on the PC so, as with the hardware, it was evaluated to the strictest criteria. Operation was checked for each supported OS. After connecting to an actual PC, drivers and utility software were installed and basic functionality was tested by repeatedly opening and closing packet connections. Then, in addition to regular usage scenarios, many variations on irregular conditions, such as when the PC is in a stand-by state, were considered and evaluated to ensure product quality.

## 5. Conclusion

In this article, we have described the development and evaluation of new data-communications terminals supporting downlink speeds of up to 7.2 Mbit/s; designed to meet the expanding demand for high-speed data-communications terminals.

We expect that the field of data-communications terminals will continue to change, with technological innovations and new user requirements, just as it has for handset-style mobile terminals. We will continue to develop new technology in response to this, including new devices with a variety of interfaces, further increased downlink speeds, and improved uplink speeds (adding support for High Speed Uplink Packet Access (HSUPA)<sup>\*10</sup>).

#### REFERENCES

- [1] M.Mori et. al: "Six Non-telephone Services for Mobile Communications Networks," NTT DoCoMo Technical Journal, Vol. 3, No. 1, pp. 32-35, Apr. 1995 (In Japanese).
- [2] S.Fujiyoshi et. al: "Outline of PHS 64K Data Transmission System," NTT DoCoMo Technical Journal, Vol. 1, No. 1, pp. 31-35, Oct. 1999.
- [3] H.Matsuoka et. al: "HSDPA Terminal Development and Radio Transmission Performance," NTT DoCoMo Technical Journal, Vol. 9, No.3, pp. 13-18, Dec. 2006.

\*10 **HSUPA**: A high speed uplink packet transmission technology based on W-CDMA and standardized by 3GPP. It optimizes the coding rate, spread factor, and transmission power according to reception conditions at the base station.