

Overview of Mobile Terminals with Bluetooth™

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Bluetooth has been attracting a great deal of attention recently, as a wireless interface adapted to browsers, Internet mail and 64kbit/s data communications. NTT DoCoMo has developed Paldio 633S, its latest Personal Handyphone System (PHS) terminal with Bluetooth.

This article reviews the functions of Bluetooth in Paldio 633S.

1. Introduction

NTT DoCoMo's PHS 64kbit/s data communication service was commercially launched in April 1994. The service has been highly demanded, and the data communication dedicated terminals P-in Series (card-type PHSs) and the Paldio Series (phone-type PHSs) are both increasing sales steadily. PHS data communication traffic currently accounts for more than half of the total calls.

With the aim to further promote data communications, NTT DoCoMo has developed a PHS terminal with Bluetooth^{*1}, the wireless interface which has been focused recently.

2. Background of Launch and Concept

As data communication with the existing PHSs required data cards and involved cable connection, users had longed for improvements to solve such inconveniences. The P-in Series, launched by NTT DoCoMo as PHS terminals aimed at expanding the population of data-communication users, were inconvenient for voice-oriented users due to their shape, designed primarily for data communications.

As a solution, NTT DoCoMo developed a new PHS terminal based on the concept of expanding the data communications range for users by taking advantage of PHS's reasonable data communication characteristics and by adopting Bluetooth as the new interface. It will also be equipped to IMT-2000 terminals in

*1 Bluetooth: Bluetooth™ is a trademark owned by Bluetooth SIG, Inc. and licensed to NTT DoCoMo.

the future. These PHS terminal may be regarded as the entry model for spreading this new technology to users.

3. Service Image

The newly developed Paldio 633S supports Bluetooth version 1.1, and is capable of using a wide range of services with devices powered by the same version as shown below.

All Bluetooth equipped devices operate according to specifications referred to as “profiles” (described in Chapter 5 in detail). Profiles may be divided into: profiles required for

Bluetooth connection; and profiles required for rendering services.” The former are profiles that are indispensable for establishing Bluetooth connection (**Figure 1**). The latter can be mounted optional depending on the device; as shown in **Table 1**, Paldio 633S has profiles relating to dial-up required for data communications and Object EXchange protocol (OBEX) which enables the exchange of information with PCs, Personal Digital Assistants (PDAs) and other devices. The profiles used for each service are as described below. An explanation of Bluetooth will be provided in the following chapter.

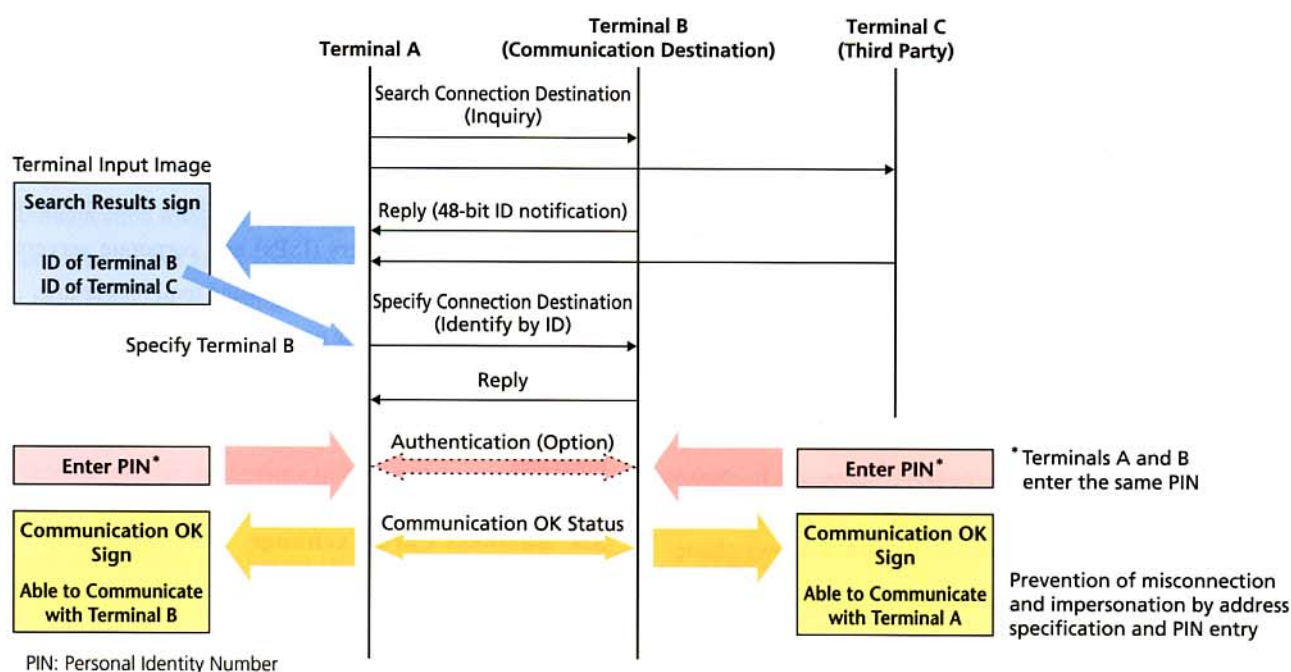


Figure 1 Bluetooth Connection Sequence

Table 1 Basic Specifications of Paldio 633S

Item Data		Specifications	
PHS Part	Size	H x W x D: Approx. 93mm x Approx. 49mm x Approx. 26mm (when folded)	
	Weight	Approx. 99g	
	Continuous Standby Time	Approx. 550 hours (in standby state at public places)	
	Continuous Call Time	Approx. 7.5 hours (assuming voice communication)	
	Continuous Communication Time	Approx. 5 hours (assuming 64kbit/s data communication using data card)	
Bluetooth	Continuous Communication Time	Approx. 2.5 hours (assuming 32kbit/s data communication)	
		Approx. 2 hours (assuming 64kbit/s data communication)	
	Continuous Standby Time	Approx. 180 hours (in PageScan mode (when standing by with Bluetooth connection))	
	Output	Bluetooth Power Class3 (1mW (Range: Approx. 10m))	
	Supported Profiles	Profiles required for Bluetooth connection	Generic Access Profile
			Service Discovery Application Profile
			Serial Port Profile
		Profiles for Dial-up	Dial-up Networking Profile
	Profiles for Data Exchange		Generic Object Exchange Profile
			Object Push Profile

3.1 Dial-up Connection

This is a function for establishing dial-up connection using Bluetooth instead the existing data cards. **Figure 2** shows dial-up connection via Bluetooth. Here, Paldio 633S serves as a modem as well as a phone.

The profiles used by Paldio 633S include the basic profiles required for Bluetooth connection, in addition to the Dial-up Networking Profile.

Upon connection, a Bluetooth link is established and the Paldio 633S is recognized as a modem by the PC or a similar device on the terminal side. For recognition, a PIN code is used to establish negotiation between interconnected terminals, so that connection will not be established accidentally with the wrong Bluetooth device. After the establishment of the Bluetooth link, dial-up connection starts based on instructions from the terminal side.

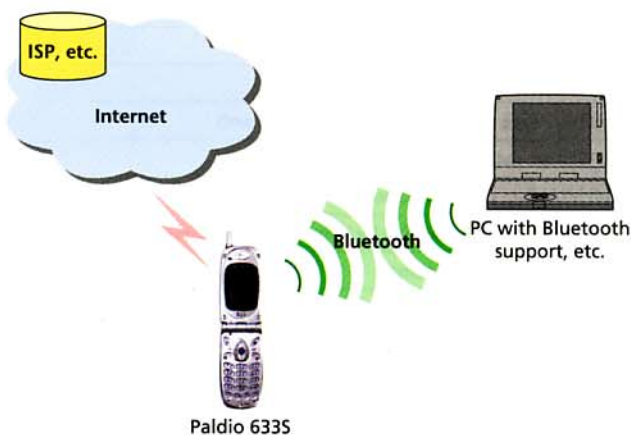
This function enables the user to make wireless connection.

3.2 Phonebook Forwarding

In addition to the basic profiles, the profiles used by Paldio 633S include the Generic Object Exchange Profile (GOEP) and the Object Push Profile (OPP).

Phonebooks are forwarded using OBEX, a protocol for exchanging objects between devices. **Figure 3** shows phonebook forwarding.

Phonebook-forwarding features of Paldio 633S include one entry transmission, all-entries transmission and reception. Information that can be forwarded include "Name," "Reading," "Phone Number," "Group Number," "Group Name," "E-mail Address," "Personal Data," "Call Termination Popup Screen Setup," and "Secret Settings." All of these items can be for-



ISP: Internet Service Provider

Figure 2 Dial-up Connection

warded if Paldio 633S is on the receiving end —otherwise, it depends on the capabilities of the receiving device.

As stated above, the protocol used for forwarding is OBEX. Meanwhile, the format used for the object (i.e. the phonebook data) is vCard, which is a standard format. As explained before, OBEX and vCard are standard formats, which are used not only in Bluetooth but also in forwarding tasks using infrared interfaces.

3.3 Mail Forwarding

Similar to phonebook forwarding, this is a function for forwarding mail transmitted, received and written by Paldio 633S using the OBEX protocol, in place of the phonebook. Figure 3 shows mail forwarding.

Paldio 633S can transmit and receive not only Paldio E-mail via the network service but also Internet mail using normal Internet Service Providers (ISPs) and corporate servers. It is suitable for expanding to services using mail forwarding.

The format of mail data used by Paldio 633S is the vMessage format. This is also a standard format, which can be used not only in Bluetooth but also in forwarding tasks using infrared interfaces.

3.4 Business Card Exchange

This is a function for transmitting and receiving personal information registered in the terminal with Bluetooth-equipped devices. As the personal information can be exchanged with other people, it can be used like business cards.

Similar to phonebook forwarding, it uses the vCard format based on the OBEX protocol to perform data exchange. Figure

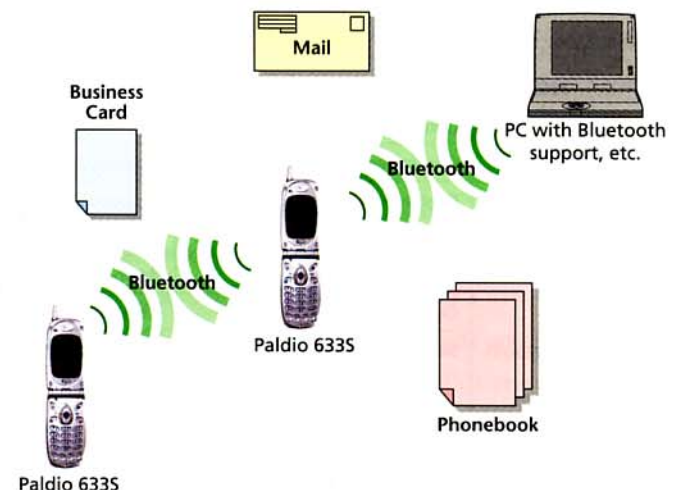


Figure 3 Phonebook Forwarding, Mail Forwarding and Business Card Exchange

3 shows business card exchange.

4. Bluetooth

4.1 What is Bluetooth?

Bluetooth is a short-range radio specification using the 2.4GHz band. Bluetooth is extremely distinctive in that: it can offer much better usability compared to existing wired connections; it can be implemented in small modules, and; it has excellent energy-saving properties. It is expected to progress in the future as the de-facto standard of wireless interface for mobile equipment. There are an increasing number of devices which are geared with this specification in Japan, centering on laptop PCs. Bluetooth is expected to play a significant role in increasing the data communication demand among households.

The technical properties of Bluetooth are as follows.

- (1) Communication Range: 10 to 100m

In order to ensure energy-saving characteristics adapted to mobile equipment, its communication range is set shorter than other radio systems. This is believed to be a sufficient communication range considering the scope of usage.

- (2) Point-to-Multipoint Connection (Up to seven devices)

In order to enable the construction of simple wireless networks, Bluetooth supports point-to-multipoint connection. The devices are divided into one master (which is in charge of communication control) and multiple slaves (no more than seven devices).

- (3) Voice and Data Communication Support

Bluetooth supports the coexistence of voice communication links for periodic synchronous communication and data communication links for asynchronous communication executed at unoccupied timings.

- (4) Security against Misconnection and Bugging

Bluetooth adopts an authentication key (fixed length of 128 bits) and an encryption key (variable length between 8 and 128 bits) to prevent misconnection and bugging. For the identification of each terminal, a 48-bit-long address is assigned uniquely to each terminal.

- (5) Frequency-hopping Spread Spectrum

Frequency-hopping spread spectrum is adopted in consideration of the impact of interference from other radio systems used in the same frequency band, because the 2.4GHz band used by Bluetooth does not require users to have a radio license. The impact of interference and jamming is reduced by changing the frequency of the carrier wave based on time.

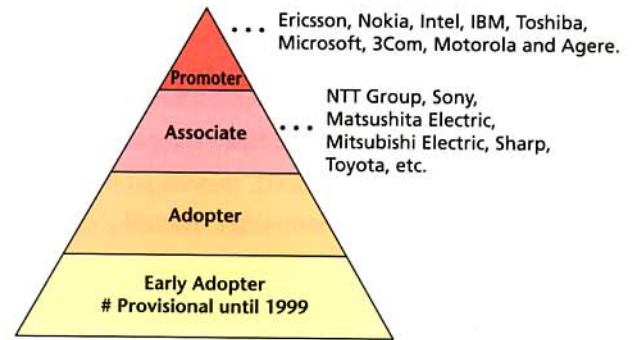


Figure 4 Membership of Bluetooth SIG

4.2 Standardization Body: Bluetooth SIG

The Bluetooth Special Interest Group (SIG) is a standardization body established for the purpose of deciding the specifications of Bluetooth. It is engaged in various activities, ranging from the formulation of the basic protocol specifications (core) and the application specifications (profile), the certification of products and promotion, to the administration of developers' meetings. The number of corporate members exceeded 2,500 worldwide as of January 2002, including chip vendors, software vendors, terminal makers and communication carriers.

Figure 4 shows the membership of Bluetooth SIG. SIG consists of Promoters^{*2}, Associates and Adopters, whose respective authorities are as follows.

- Promoters

Nine companies that form the nucleus of Bluetooth SIG. Promoters have the authority to participate in the formulation of both core specifications and profile specifications.

- Associates

Members who pay an annual membership charge according to their respective sales. Associates have the authority to participate in the formulation of profile specifications.

In the NTT Group, the holding company is an Associate member. Subsidiaries in which the holding company has a majority interest (including NTT DoCoMo) are also given the same authority as the Associate.

- Adopters

Members who can use the specifications but have no authority to formulate them. No membership charge. Companies who wish to commercialize their products in compliance with the specifications must acquire Adopter status or higher.

^{*2} Promoters: There are nine Bluetooth Promoters, namely, Toshiba, Nokia, Ericsson, IBM, Intel, Microsoft, Agere, 3Com, and Motorola.

5. Profile Specifications

Bluetooth sets forth upper-layer application specifications called “profiles” in order to assure basic compatibility at the application level. As of January 2002, thirteen profiles existed according to the scope of Bluetooth usage, including the “Dial-up Networking Profile” for dial-up communication, and the “Headset Profile” for voice communication using a headset (Table 2).

Table 2 Established Profiles

No	Name	Description
1	GAP	General connection procedures
2	SDAP	Service search
3	Cordless Telephony	For intercoms
4	Intercom	For transceivers
5	SPP	Serial data forwarding
6	Headset	For headset communication
7	Dial-up Networking	For dial-up communication
8	FAX	For FAX
9	LAN Access	For LAN
10	GOEP	Exchange of general objects (phonebook, calendar information, etc.)
11	OPP	Object exchange
12	File Transfer	For file forwarding
13	Synchronization	For data synchronization

GAP: Generic Access Profile
GOEP: Generic Object Exchange Profile
LAN: Local Area Network
OPP: Object Push Profile
SDAP: Service Discovery Application Profile
SPP: Serial Port Profile

In addition to the above, new profile standards are being established to extend the users’ scope of Bluetooth [1].

6. Conclusion

This article described a detailed explanation of Bluetooth-equipped PHS terminal. Loading Bluetooth on PHS terminal is believed to be the key to exploring new frontiers in data communication services. The technology’s potential is not limited to improving usability from the users’ point of view; it is also expected to serve as the stepping stone for the deployment of a wide range of terminals, and the construction of seamless home networks.

It is likely to progress towards services in new areas, and our challenge for the future is how to expand the services using Bluetooth.

REFERENCES

[1] Website of Bluetooth SIG <http://www.bluetooth.com/>

GLOSSARY

GAP: Generic Access Profile
GOEP: Generic Object Exchange Profile
ISP: Internet Service Provider
LAN: Local Area Network
OBEX: Object EXchange protocol
OPP: Object Push Profile
PDA: Personal Digital Assistant
PIN: Personal Identity Number
SDAP: Service Discovery Application Profile
SIG: Special Interest Group
SPP: Serial Port Profile