

OFFICEED Service System

The OFFICEED service provides flat-rate voice calls between FOMA terminals, and between FOMA terminals and terminals under user PBXs. New equipment has also been developed to facilitate the connection of PBXs and BS-DTM to support this service.

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1. Introduction

As a successor to the PASSAGE for corporate solution, NTT DoCoMo has provided the PASSAGE DUPLÉ and Business mopera IP Centrex services using FOMA/wireless LAN dual terminals and a wireless LAN system. Both are characterized by the ability to handle calls on both inside and outside lines using a wireless LAN.

Also desirable is an internal solution not relying on the use of a wireless LAN or restricted in its ability to use any terminal. With this in mind, NTT DoCoMo developed the OFFICEED service for flat-rate voice calls between FOMA terminals [1]. This service provides speed dialing and call-holding/transferring as the basic functions needed for voice calls made on inside lines. **Figure 1** shows the positioning in relation to the PASSAGE DUPLÉ and Business mopera IP Centrex services.

This service provides flat-rate voice calls between FOMA terminals within the OFFICEED area in a user's building, and

between terminals operating under a Private Branch eXchange (PBX) (hereinafter referred to as "terminals under PBX") and FOMA terminals within the OFFICEED area. The OFFICEED area is defined as that covered by the Inbuilding Mobile Communication System (IMCS)^{*1} equipment of the IP system within a user's building.

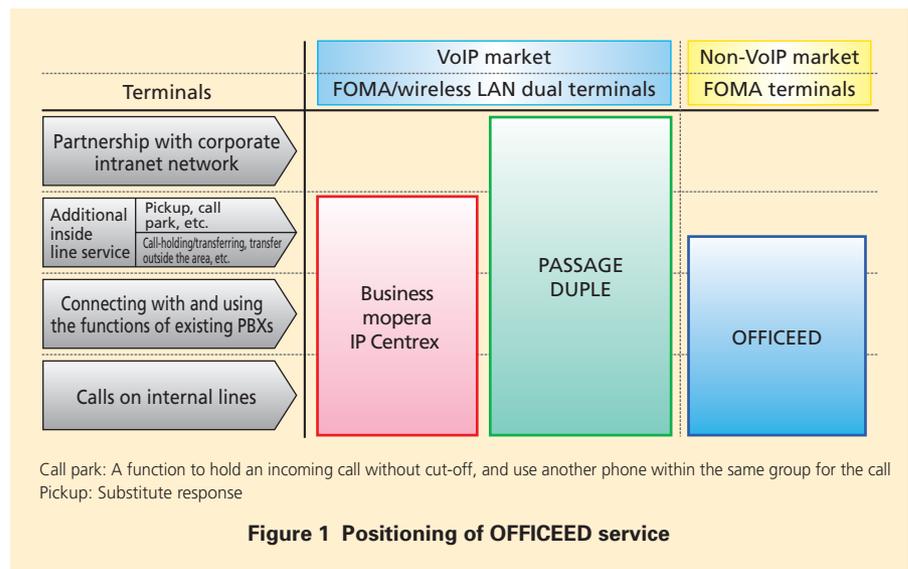
Since this service handles calls made within a building, unlike the normal FOMA calls, a method of establishing calls within a building used between

FOMA terminals, and for calls between FOMA terminals and terminals under PBX is adopted to reduce communication costs. **Figure 2** shows the connection.

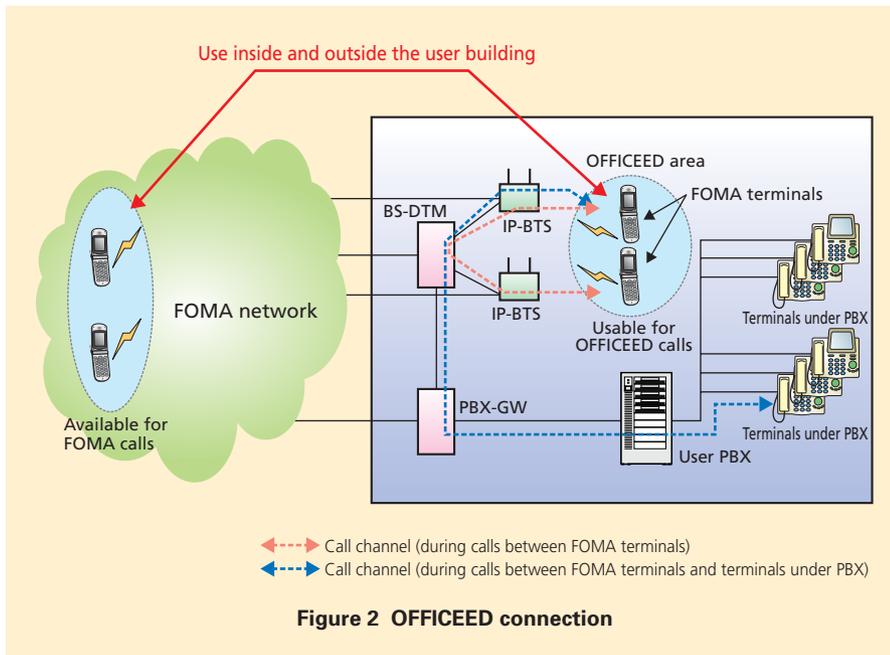
This article describes an overview of the OFFICEED service and network control, and the system configuration and overview of the new equipment necessary to establish calls within a building when connecting to the PBX.

2. Service Overview

The OFFICEED service provides the



*1 **IMCS**: NTT DoCoMo's system that allows communication in places such as high-rise buildings, underground areas and other locations where it is difficult or impossible for mobile terminals to make connections.



following functions:

- 1) Calls between FOMA Terminals within the user building
Permits voice and video phone communications between FOMA terminals within the OFFICEED area. Terminals are called by dialing *55 + the other party's mobile phone number.
- 2) Calls between FOMA Terminals and Terminals under PBX within the user building
Permits voice communications between FOMA terminals and terminals under PBX in the OFFICEED area. Operation is enabled by dialing *55 + the inside line number of the terminal connected under the PBX (hereinafter referred to as the "PBX terminal number"). This function is provided in addition to those specified in the OFFICEED contract in units of OFFICEED groups*2 under a contract concluded for PBX connection service.

- 3) Speed Dialing Numbers
Speed dialing numbers are allocated to FOMA terminals, and calls within the user building are made by dialing *55 + speed dialing number*3.
- 4) Call Forwarding outside the OFFICEED Area
A call is connected as a normal FOMA call (volume-controlled charging) when the called party is outside the OFFICEED area.
- 5) Call-holding/Transferring
The call-holding/transferring function can be initiated from a FOMA terminal during a call made within the user building.
- 6) OFFICEED Priority Connection
When only the other party's mobile phone number is dialed and the calling and called parties are within the OFFICEED area, the call is connected as a call within the user building (flat-rate); when the calling or called party is outside

*2 **OFFICEED group:** A unit of members for which flat-rate calls are possible. The group representative batch-registers the FOMA terminals of group members when the OFFICEED service contract is concluded.

*3 **Speed dialing number:** In this article, a number comprising 2 to 8 digits assigned to a FOMA terminal which are unique to each OFFICEED group.

the OFFICEED area, the call is connected as a normal FOMA call (volume-controlled charging).

3. Network Control Overview

3.1 OFFICEED Basic Call Connection

OFFICEED basic call connection requires that both the calling and called parties belong to the same OFFICEED group, and are within the OFFICEED area.

Figure 3 shows the OFFICEED basic call sequence. When the caller dials *55 + the other party's mobile phone number from a FOMA terminal (in Fig. 3 (b) (1)), the Local Mobile Multimedia switching System (LMMS)*4 is notified of a call request (in Fig. 3 (b) (2)). After evaluating the caller's OFFICEED contract (in Fig. 3 (b) (3)), the LMMS notifies the IP-Radio Network Controller (IP-RNC)*5 of a call connection request (in Fig. 3 (b) (4)). The OFFICEED group ID for which calls are possible within the user building is pre-registered in the IP-RNC with the IP-Base Transceiver Station (IP-BTS)*6. The IP-RNC determines whether a call is made from within the OFFICEED area from the OFFICEED group ID set in the call connection request sent from the LMMS and the IP-BTS in which the caller is located (in Fig. 3 (b) (5)). When the caller is located within the OFFICEED area, the Base Station-Data Transfer Module (BS-DTM)*7 is instructed to establish a call channel for connection within the user building (in Fig. 3 (b) (6) and (7)), and the

*4 **LMMS:** A switching system at the subscriber level for circuit-switching communication in the FOMA network.

*5 **IP-RNC:** Equipment for radio circuit control and mobile control for IP transmission channels.

LMMS is notified of a call connection response (in Fig. 3 (b) (8)).

The LMMS then sends an inquiry to the Service Control Point (SCP)^{*8} to determine the status of the called party's OFFICEED contract, and upon receiving response (in Fig. 3 (b) (9), (10), (11)), it notifies the IP-RNC of a receive connection request (in Fig. 3 (b) (12)). The IP-RNC determines whether a call is made from within the OFFICEED area or not from the OFFICEED group ID set in the receive connection request sent from the LMMS and the IP-BTS in which the called party is located (in Fig. 3 (b) (13)). When the caller is located within the OFFICEED area, the IP-RNC instructs the BS-DTM to establish a call channel for connection within the user building

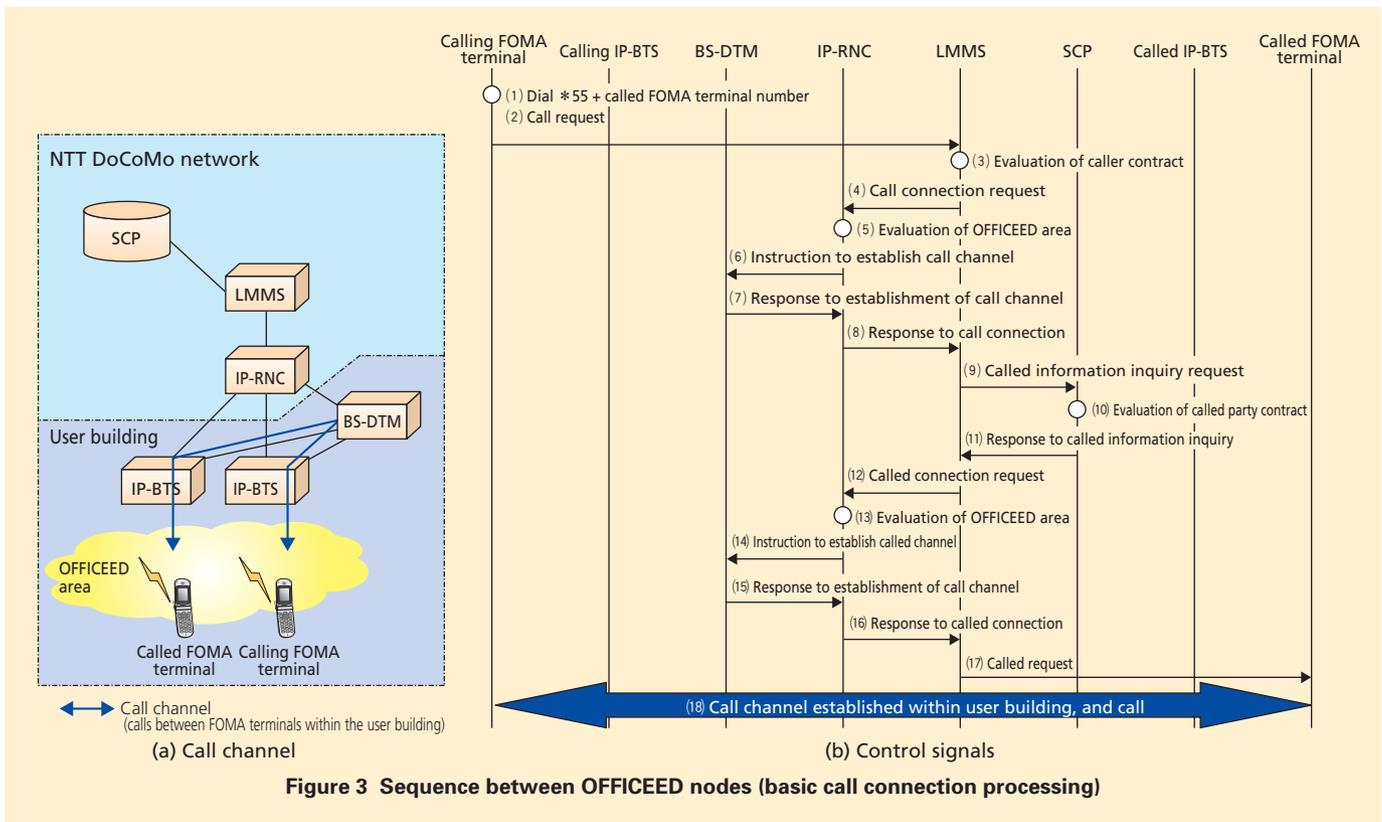
(in Fig. 3 (b) (14) and (15)), and notifies the LMMS of receive connection response (in Fig. 3 (b) (16)). The LMMS notifies the receiving FOMA terminal of the receive request (in Fig. 3 (b) (17)) and the call channel is established within the user building (in Fig. 3 (b) (18)).

3.2 PBX Connection and Speed Dialing Number Functions

The PBX connection function provides for calls between FOMA terminals under the same OFFICEED group ID and terminals under PBX for users having a PBX connection service contract in addition to an OFFICEED contract, and permits connection with the *55 + PBX terminal number.

The PBX-GateWay (PBX-GW) was

developed to implement this function. The PBX-GW incorporates the Signaling and Media Gateway (SMG) responsible for conversion between Integrated Services digital network User Part (ISUP)^{*9} and Session Initiation Protocol (SIP)^{*10}, and the conversion of voice data coding for interconnecting FOMA and PBX networks, while simultaneously converting control signals to SIP. Chapter 4 describes an overview of this equipment. Moreover, a number conversion function to determine the routing information (hereinafter referred to as "PBX-GW information") from the dialed PBX terminal number to the PBX when a call from a FOMA terminal is received by a terminal under PBX has been added to the SCP (hereinafter referred to as the "number conversion



*6 **IP-BTS**: Wireless base station equipment for IP transmission channels.

*7 **BS-DTM**: Equipment installed within the user building providing a function for establishing voice data and Audio Visual (AV) data channels, and permitting calls within the building.

*8 **SCP**: Equipment supporting functions for managing subscriber service information (contract and setup information) and controlling services.

*9 **ISUP**: A part of the Signaling System No.7 (SS7). A protocol used for control of public switched telephone networks, and handles connection processing in ISDN.

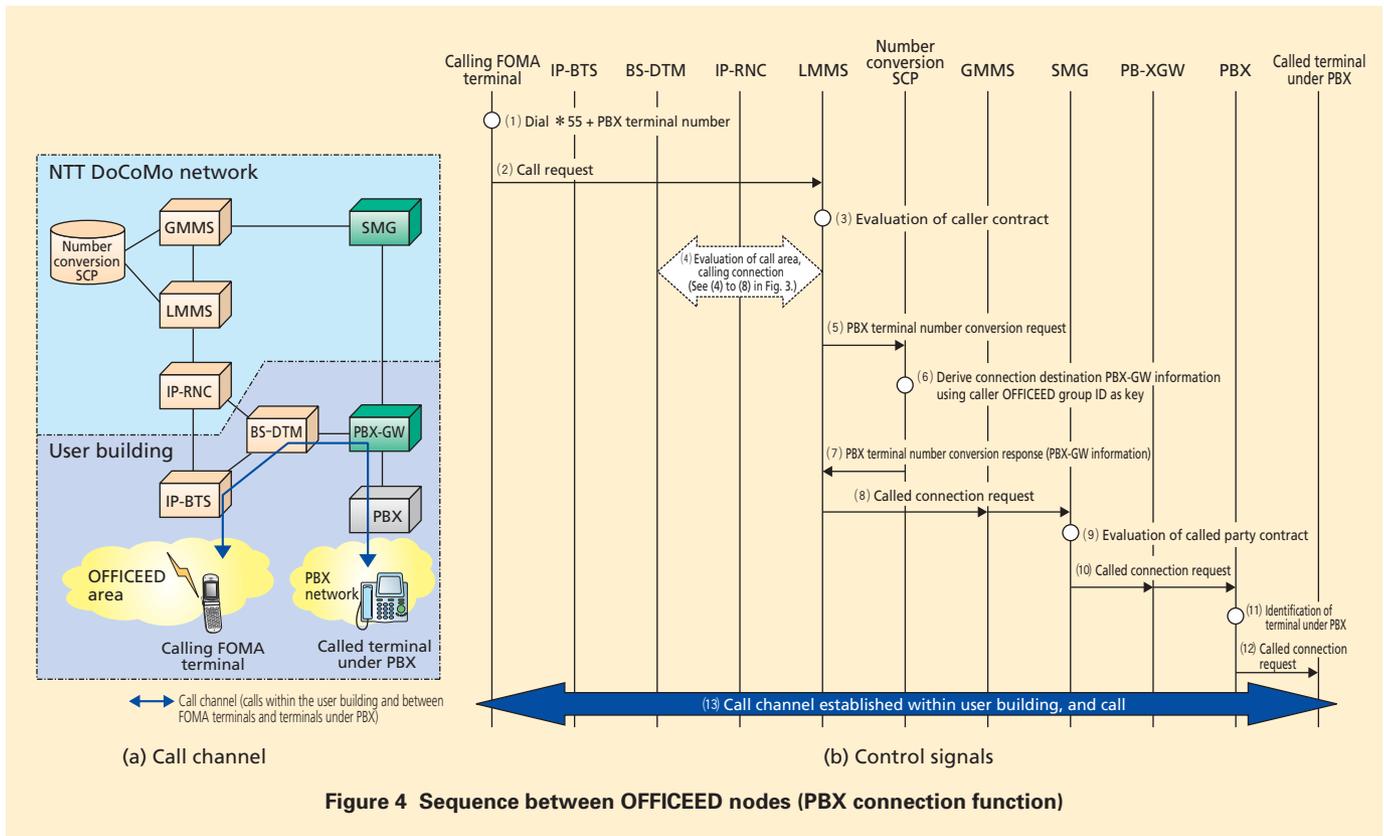


Figure 4 Sequence between OFFICEED nodes (PBX connection function)

SCP”), and a function to connect to the PBX from the PBX-GW information has been added to the LMMS and SMG.

Figure 4 shows the PBX connection sequence. When *55 + PBX terminal number is dialed from a FOMA terminal (in Fig. 4 (b) (1)), the LMMS receiving the call request for the terminal under PBX (in Fig. 4 (b) (2)) evaluates the OFFICEED contract (in Fig. 4 (b) (3)) and the call area (in Fig. 4 (b) (4)). A number conversion request for the PBX terminal number is then sent to the number conversion SCP (in Fig. 4 (b) (5)). The number conversion SCP derives PBX-GW information for the connection destination by using the caller’s OFFICEED group ID as a key (in Fig. 4 (b) (6)), and then sends a response to the

LMMS (in Fig. 4 (b) (7)). The LMMS determines routing based on the PBX-GW information received, and is connected to the SMG via the Gateway Mobile Multimedia switching System (GMMS)^{*11} (in Fig. 4 (b) (8)). The SMG evaluates the called party PBX contract (in Fig. 4 (b) (9)), and then connects to the PBX via the PBX-GW (in Fig. 4 (b) (10)). The PBX identifies the terminal operating under the PBX (in Fig. 4 (b) (11)) based on the PBX terminal number, and sends a receive connection request (in Fig. 4 (b) (12)). In this way, calls can be made within the user building between FOMA terminals, the IP-BTS, BS-DTM, PBX-GW, PBX and terminals under PBX (in Fig. 4 (b)(13)).

The speed dialing number function allocates speed dial numbers to FOMA

terminals and permits the reception of calls on FOMA terminals using the *55 + speed dial number. In the same manner as for PBX terminal numbers, speed dialing numbers are also included in the speed dialing list at the number conversion SCP and converted.

This function enables dialing using the speed dial number when a FOMA terminal receives a call from a terminal operating under PBX. The GMMS sends a number conversion request to the number conversion SCP, and then determines routing with the FOMA number acquired.

3.3 Transfer Outside the OFFICEED Area

When an attempt is made to establish a connection within the user building, and

*10 SIP: A call control protocol defined by the Internet Engineering Task Force (IETF) for IP telephony, etc.

*11 GMMS: A gateway switching system with other operators for circuit-switched communications on a FOMA network.

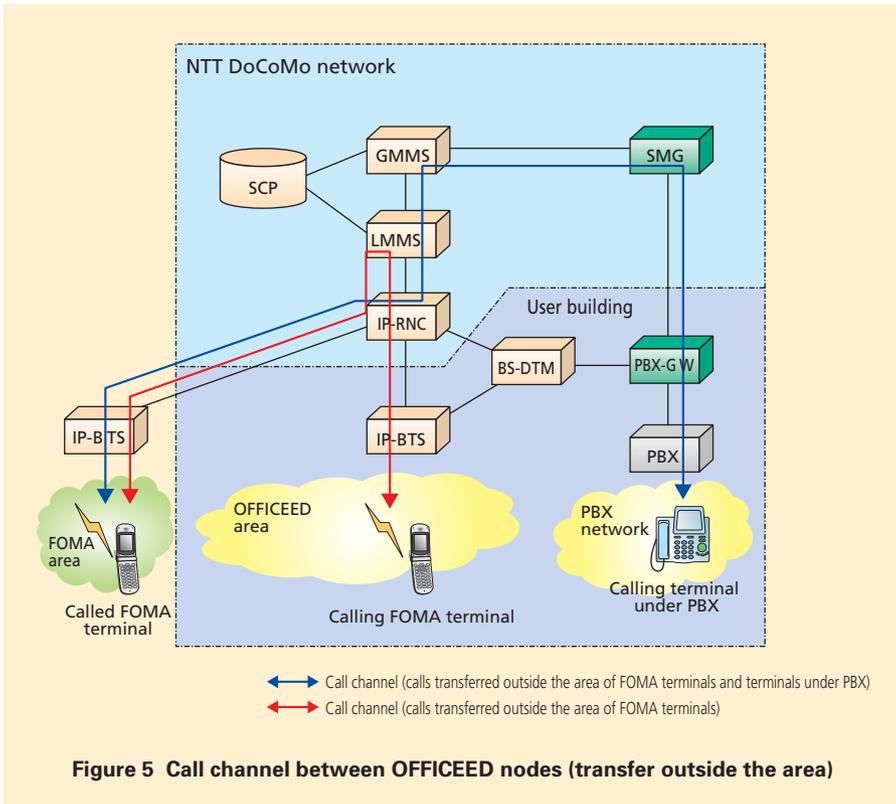


Figure 5 Call channel between OFFICEED nodes (transfer outside the area)

the called party is outside the OFFICEED area and within the FOMA area, the call may be connected as a FOMA call. **Figure 5** shows the call channel for transfer outside the OFFICEED area.

1) Calls between FOMA Terminals

The LMMS sends an inquiry to the IP-RNC of the called party. If the party is evaluated as being outside the OFFICEED area, a call channel for connection within the user building is released and a FOMA connection call channel established.

2) Calls from Terminals under PBX

When the called party is outside the OFFICEED area, an instruction is sent via the SMG to establish a call channel for FOMA connection to the PBX-GW, and the PBX-GW establishes the call channel

via the SMG instead of the BS-DTM.

3.4 Other Functions

The call-holding/transferring function temporarily holds a call before transferring it to other phone. The LMMS receiving a call-holding/transferring request issues an instruction to connect the BS-DTM for the user on hold and the user at the transfer destination within the user building.

An OFFICEED priority connection function is also available. When only the other party's mobile phone number is dialed, this function connects the call as OFFICEED call within the OFFICEED area or as FOMA call outside the OFFICEED area. This processing evaluates calls made within the OFFICEED

area with the LMMS, and calls received within the OFFICEED area with the SCP. The call channel is selected according to the evaluated locations of the calling and called parties.

4. New Equipments Overview

The SMG and PBX-GW described in Chapter 3 are newly developed as equipment to implement connection of FOMA terminals and terminals under PBX for the OFFICEED service.

Figure 6 shows the system configuration regarding each unit of equipment; **Table 1** shows the main functions of the equipment. The SMG is positioned between the FOMA network and PBX-GW for call control of connections between FOMA terminals and terminals under PBX. A function is also provided to select call channels depending on whether the called FOMA terminal is within the OFFICEED area. Call control signals exchanged between FOMA terminals and terminals under PBX entail connection via an IP network and the use of SIP as a protocol, and thus permit low-cost and flexible routing control in anticipation of the future comprehensive introduction of All-IP between the SMG and the PBX-GW. Since control signals in the FOMA network adopt ISUP, the SMG converts the SIP and ISUP control signals.

The PBX-GW is connected to the SMG, user PBX, and BS-DTM. Calls can be made within the user building without passing through a core network by establishing a call channel between the PBX-GW and BS-DTM. Two types of PBX-

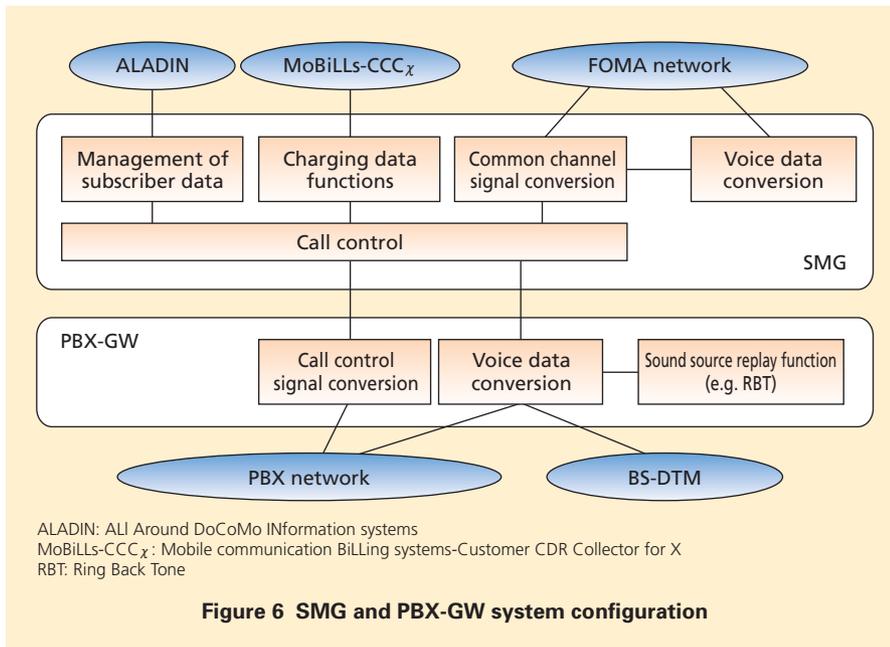


Figure 6 SMG and PBX-GW system configuration

Table 1 Main functions of SMG and PBX-GW

Equipment	Functions	Outline
SMG	Call control	Control of initiation and receipt of calls on connection between FOMA terminals and terminals under PBX
	Common channel signal conversion	Conversion of exchange signal protocol (ISUP) and PBX-GW signal protocol (SIP) for setting up calls with exchange
	Voice data conversion	Physical conversion of exchange transmission interface (STM) and PBX-GW transmission interface (IP) for voice communications with exchange when transferring outside the OFFICEED area
	Management of subscriber data	Receipt of information set from ALADIN and management of such subscriber data as PBX connection contracts
	Charging data	Transmission of charging information to MoBiLLs-CCC χ
PBX-GW	Call control signal conversion	Conversion of SMG signal protocol (SIP) and user PBX signal protocol (Q.931a or analog phone) for setting up calls with user PBX
	Voice data conversion	Physical conversion of SMG transmission interface (IP) and user PBX transmission interface (OD/PRI) for voice communications with user PBX
	Sound source replay	Sending of sound source (e.g. RBT) to respond to request from exchange

STM: Synchronous Transfer Mode

GW are provided as user PBX interfaces — the Out band Dialing (OD)^{*12} type, and the Primary Rate Interface (PRI)^{*13} type. **Photo 1** shows both types and **Table 2** shows the basic specifications. Connection between the PBX-GW and user PBX is made by analog phone for the OD type, and by Q.931a^{*14} for the PRI type. The PBX-GW therefore converts voice data coding while simultaneously converting

control signals for each protocol to SIP. Connection between FOMA terminals and terminals under PBX is implemented at low-cost by converting the protocol for each type of interface in each unit of equipment. Furthermore, since the PBX-GW is installed within the user building, sufficient capacity for expansion should be provided to cover the number of users and the volume of traffic. Therefore, mul-



Photo 1 External view of PBX-GW

Table 2 PBX-GW basic specifications

	OD type	PRI type
Number of simultaneous connections	4 ch	23 ch
Size (mm)	W210 X D163 X H38	W430 X D250 X H44
Weight	1 kg	3 kg

multiple PBX-GWs can be installed according to the size of a user PBX.

The SMG is implemented by installing related software on a group of general-purpose servers, and development of the PBX-GW as new hardware based on the general-purpose Voice over IP-GateWay (VoIP-GW)^{*15} enables low-cost implementation.

5. Conclusion

This article has described an overview of the OFFICEED service and network control, and the system required for connection of PBXs and BS-DTMs. The functions of the system will be further expanded in response to future requirements.

REFERENCES

- [1] F. Kato et al.: "Base Station-Data Transfer Module," NTT DoCoMo Technical Journal, Vol.9, No.1, pp.22-24, Jun.2007.

*12 OD: A 4-wire analog phone circuit interface widely used in PBXs, etc.

*13 PRI: A primary group interface for ISDN circuits defined by the International Telecommunication Union Telecommunication standardization sector (ITU-T).

*14 Q.931a: An ITU-T recommended procedure for sending and receiving using the D channel in ISDN.

*15 VoIP-GW: A gateway connected to a PBX for converting voice data for IP transmission (VoIP).