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Enterprise-oriented Internal Line Service FOMA Internal Line Service Internal Line Optional Functions

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Technology Reports

Office Link System for FOMA Internal Line Connections

Although we have previously offered "OFFICEED," "business mopera IP Centrex" and other internal line services for the enterprise, the service area has been limited to within buildings. In response to the high demand for an internal line service that can be used nationwide, we developed the Office Link system and began offering the "Office Link" service in September 2009. This service is implemented through interworking between the PBX and FOMA network that many enterprises already have in place. Extension line call control and optional service control are implemented by using functions of the business mopera IP Centrex service.

1. Introduction

NTT DOCOMO has previously offered three internal line service solutions aimed at raising productivity by facilitating calling within an enterprise. One is "OFFICEED" [1], which uses the In-building Mobile Communication System (IMCS)^{*1} and FOMA terminals, and the other two are "PASSAGE DUPLE" and "business mopera IP Centrex" [2], which use a wireless LAN and FOMA/wireless LAN dual terminals.

Those services mainly provide an area limited to within the enterprise building, but for further convenience, we studied provision of an internal line service that opens up the service area to the entire country. We began to offer

Table 1	Provision	conditions	for	the	internal	call	service

	Office Link	OFFICEED	IP Centrex	PASSAGE DUPLE					
Area	Nation-wide FOMA area	Dedicated IMCS area	Dedicated wireless LAN area	Dedicated wireless LAN area					
Terminal	All FOMA terminals	All FOMA terminals	Wireless LAN compatible terminal	Wireless LAN compatible terminal					
Area construction	Not needed (interworking with user's existing internal line system)	OFFICEED area must be constructed (IMCS installation)	Wireless LAN area must be constructed	Wireless LAN area must be constructed					
PBX function outsourcing (internal line control function outsourcing)	Possible	Possible	Possible	Not possible					

*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. *2 **PBX**: An enterprise private branch exchange; it has functions for internal line connection as well as external line connections.

enterprise Private Branch Exchange (PBX)^{*2} and the FOMA network. This allows the user to use the internal line service throughout the nationwide FOMA area, thus facilitating communication within the enterprise regardless of location. The service provision conditions are shown in **Table 1**. The posi-

the "Office Link" internal line service,

which works through cooperation of the

tioning of the internal call service is shown in **Table 2**.

This article describes an overview of the Office Link service, which provides basic connection and internal line optional services, and explains its implementation.

2. Service Overview

Office Link provides a call service that allows users to call each other by internal line number as well as internal line optional services between FOMA terminals in a FOMA area (**Figure 1**(a)), between telephone terminals under a PBX that extends across offices (Fig. 1(b)), and between the telephone terminals under the PBX and the FOMA terminals in the FOMA area (Fig. 1(c)).

 Internal Line Calls for FOMA Terminals

This service provides an internal line call function for FOMA terminals residing in a FOMA area. FOMA terminals that belong to the same subscriber (i.e., the same enterprise) can call each other by internal line number with flat-rate calling, thus proving the following benefits to the user.

- Extension line calls can be made throughout the nation-wide FOMA area.
- Because all FOMA terminals capable of voice calls can be used, users can choose to use a FOMA terminal they already have or any other type.
- Extension Line Calls for PBX This provides an internal line call





Table 2 Positioning of the internal call service

function for a PBX installed in a user's office. Telephone terminals under the PBX can make internal line calls with FOMA terminals and other offices of the same subscriber (i.e., the same enterprise), thus providing the user with the benefits listed below.

- Enterprises that already have PBX can use Office Link without changing those facilities and settings.
- Flat-rate calling from internal line numbers is possible between telephone terminals under PBX that span across offices as well as calls between terminals under the PBX of the same office, and is also possible between telephone terminals under a PBX and FOMA terminals within the FOMA area.

 Internal Line Optional Services The following internal line optional services within the same subscriber (i.e., the same enterprise) are offered.

- Transfer: A function for transferring calls to other terminals (transfer after answering, transfer during a call, unconditional transfer, delayed answer transfer, or transfer when out of area).
- Call park: A function that allows the current call to be put on hold to a specified park group by dialing an "internal line number for park hold plus the park group number" so that other terminals in the park group can accept and continue the call.
- Pickup: A function in which a pickup group is formed in advance and

calls to any terminal within the pickup group can be accepted by one's own terminal.

- Group pickup: A function in which calls call to a group to which one's terminal does not belong can be accepted at one's own terminal.
- Caller number notification/display: A function for setting the caller number notification. It can be set to notification or non-notification.

In this way, users of FOMA termi-

nals can use the internal line optional services in the same way as a PBX internal line.

3. System Overview 3.1 System Configuration

The Office Link system configuration is shown in **Figure 2**. A system configured with Office Link is shown by (1) to (6) in the figure. Of those, (1) to (4) are NTT DOCOMO facilities; (5) and (6) are user facilities.

The service control for providing



call control and internal line optional services, etc. is mainly done by the business mopera IP Centrex server group (hereinafter referred to as "IP Centrex server group"). For that reason, the Office Link internal line optional services and voice guidance basically make use of business mopera IP Centrex service functions.

3.2 Functional Division

The following is an overview of the functional division of the equipment used to provide the Office Link service. (1) IP Centrex server group

This server group performs internal line in-coming and outgoing call control and internal line optional services control for the IP Centrex service. It provides the same function in Office Link.

(2) Session Initiation Protocol (SIP)⁺³GW equipment

This relays SIP signals between the IP Centrex server group and the FOMA network and detects Dual-Tone Multi-Frequency (DTMF)^{*4}.

(3) Number conversion equipment(Call Serving Server)

This equipment performs message relay and number conversion between the IP Centrex server group and the FOMA network in the IP Centrex service. It performs the same functions for Office Link.

- (4) FOMA network GW equipment(Signaling and Media Gateway)This performs ISDN User Part
- *3 **SIP**: A call control protocol defined by the Internet Engineering Task Force (IETF) and used for IP telephony with VoIP, etc.

(ISUP)^{*5} and SIP conversion and media conversion of voice data in the OFFICEED service. It provides the same functions in Office Link.

(5) FOMA terminal

When using Office Link, the terminal sends in-coming or outgoing calls and DTMF with the internal line number. Because existing FOMA terminals have these functions, all FOMA terminals that are capable of voice communication can use Office Link.

(6) PBX equipment

This connects to the IP Centrex server group via the access transmission path, enabling use of Office Link between telephone terminals under a PBX extending across offices or between FOMA terminals in the FOMA area and telephone terminals under the PBX.

3.3 Call Origination and Termination Sequences

The internal line number call origination sequence for the FOMA terminal is shown in **Figure 3**; the call termination sequence is shown in **Figure 4**.

 FOMA Internal Line Sequence for Call Origination

When a call is made dialing an internal line number, the FOMA network GW equipment that receives the ISUP Message (IAM) converts from ISUP to SIP. Next, the number conversion equipment that receives the SIP_INVITE maps from the phone number (090/080 number) of the calling FOMA terminal to the internal line number. The IP Centrex server group that receives the SIP_INVITE via the SIP GW equipment performs call control and then the receiving terminal responds.

2) FOMA Internal Line Sequence for Call Termination

The number conversion equipment that receives the SIP_INVITE that has the destination number set to an internal line number from the IP Centrex server group via the SIP GW equipment maps between the internal line number and the 090/080 number. Then, the FOMA network GW equipment that receives the SIP_INVITE from the number conversion equipment converts from SIP to ISUP and sends the ISUP signal to the FOMA network. The receiving terminal then responds.

4. Service Implementation Functions

4.1 Dialing an Internal Line Number from a FOMA Terminal

For an internal line connection from a FOMA terminal, if a numeral from 2 to 9 that is used by the FOMA service is specified in front of the dialed destination number, the FOMA network checks the user profile on the calling terminal side. The user profile contains an enterprise ID, which specifies whether or not this is an enterprise user. That ID is appended to the internal line number and the FOMA network then

als 0 through 9 and the asterisk (*), pound sign (#), and high and low tones from A to D.

^{*4} DTMF: Also referred to as a push signal. The tones can be used to send a total of 16 different signals using four combinations of the numer-

^{*5} ISUP: Part of the Signaling System No.7 (SS7) common channel signaling scheme used to control the public switched telephone network.





connects to the FOMA network GW equipment.

4.2 Relating Internal Line Numbers and Mobile Terminal Phone Numbers (090/080 number)

According to the user settings, a correspondence is made between mobile terminal phone numbers that are contracted for a FOMA internal line and internal line numbers that may begin with any numeral from 2 to 9. The user profile is maintained by the number conversion equipment. The user profile also maintains a correspondence with office domains (Closed Users Group (CUG^{*6})).

As shown in Fig. 3, when an internal line number is called from a FOMA terminal, the number conversion equipment that receives the signal checks the user profile and converts the calling mobile terminal phone number to an internal line number. The enterprise domain received in a notification from the FOMA network GW equipment is converted to an office domain that the IP Centrex equipment can recognize. After conversion, the number conversion equipment connects to the SIP GW equipment.

As shown in Fig. 4, when there is an internal line number call to a FOMA terminal, the number conversion equipment that received the signal checks the user profile and converts the in-coming call internal line number to a mobile terminal phone number and converts the office domain to an enterprise domain. After conversion, the number conversion equipment connects to the FOMA network GW equipment.

4.3 Receiving an Internal Line Number Call to a FOMA Terminal

In an internal line number call to a FOMA terminal, the FOMA network GW equipment identifies the enterprise domain, assigns an ID to the enterprise user, and connects to the FOMA network. The FOMA network uses the ID to identify the incoming FOMA internal line call, controls the FOMA network optional services, and sends the call to the FOMA terminal.

4.4 Control for the FOMA Terminal Internal Line Optional Services

The IP Centrex server group sees the FOMA terminal as an internal line telephone terminal and provides the various call transfer services as well as pickup and other such internal line optional functions. Call transfer after answering and other internal line optional services used from a FOMA terminal during a call are implemented by the SIP GW equipment sending a DTMF as voice data to send the IP Centrex server group a hold signal. The DTMF can be set by the user for each user office.

4.5 Connecting FOMA Terminals and Enterprise PBX Equipment

The PBX equipment of the enterprise uses the GW connection function of the IP Centrex server group to connect to the FOMA terminal with the internal line number. The internal line optional services of a FOMA terminal connecting to an internal line are controlled by the IP Centrex server group, and the internal line optional services of internal line telephone terminals under the enterprise's PBX are controlled by the PBX, so the PBX on the enterprise and the IP Centrex server group have independent group settings for internal line optional service control.

5. Conclusion

We have presented an overview of the Office Link service, described the system briefly, and explained the functions for implementing the service.

In future work, we will continue to study additional functions for enterprise internal call services, such as the direct internal line control of FOMA terminals by enterprise IP-PBX^{*7}.

REFERENCES

- T. Kodama et. al: "OFFICEED Service System," NTT DoCoMo Technical Journal, Vol.9, No.2, pp.4-9, Sep. 2007.
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^{*6} **CUG**: A grouping concept used for identifying offices in the Centrex service.

^{*7} **IP-PBX**: A PBX that handles IP and uses for SIP control signals, etc.