Technology Reports

Business mopera IP Centrex Service System

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A system has been developed which uses the N900iL dual FOMA/wireless LAN mobile terminal to provide an IP Centrex service for communication within the office via a wireless LAN, and outside the office via FOMA network.

1. Introduction

A recently introduced business mopera IP Centrex service is expected to increase the number of user and expand usage. The service is based on a private solution for corporate application, and uses the N900iL dual FOMA/wireless LAN mobile terminal.

Typical examples of private solutions for corporate application previously developed by DoCoMo include the linkage of user-owned Private Branch eXchanges (PBXs) and PHS terminals, and the 'PASSAGE DUPLE' IP phone system combining the N900iL terminal, Session Initiation Protocol (SIP)[*1] server, and a wireless LAN system. Both solutions require installation of a PBX or IP-PBX at the user site to provide a solution that can be customized to individual user requirements, but on the other hand, are limited to comparatively large-scale corporate use due to high initial installation costs.

Conversely, the business mopera IP Centrex service installs the IP-PBX in the DoCoMo network rather than at the user site, and concentrates multiple users efficiently into a single Centrex system, providing such services as calls on both internal and external lines, and a variety of additional functions. Initial installation costs are therefore reduced, thereby permitting an expansion of target users (including small and medium-sized corporations (**Figure 1**). The provision of this service in which DoCoMo plays a part of the user's key business shifts the initia-

*1 SIP: A call control protocol defined by IETF (Internet Engineering Task Force) and used for IP phones with VoIP.

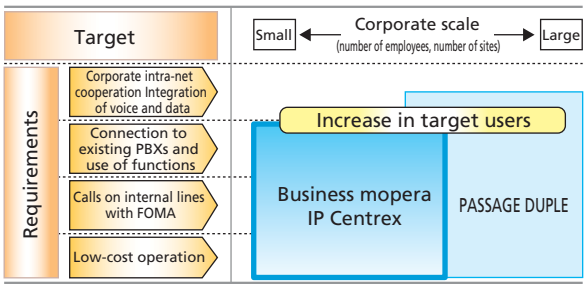


Figure 1 Increase in target users

tive in marketing and providing service from conventional communications dealers and system integrators to DoCoMo, so that operations are no longer simply a matter of selling terminals, and realize deployment of DoCoMo's solutions that are more closely related with the user's internal system.

This article provides an overview of the functions supported by the business mopera IP Centrex service, its system configuration, and the functions developed for use with the service.

2. Supported Functions

The business mopera IP Centrex service supports the following functions:

- Calls on internal lines: Calls within a corporation using extension numbers (intra-site, inter-site). Shown in yellow in **Figure 2**.
- Calls on external lines: Calls and receiving on external lines using the '050' prefix for IP phones. Shown in blue in Fig. 2.
- Connection of other equipment: Linkage (calls on internal lines and transfers) with existing equipment (PBXs) using Voice over Internet Protocol - GateWay (VoIP - GW). Shown in red in Fig. 2.
- Additional functions for internal lines: Hold, transfer, pick-up (phone answering service), call park[*2], call hunting[*3] etc.
- Presence function: Confirmation of presence-at-desk information on registered members (communication status within the wireless LAN area) via wireless LAN and i-mode (**Figure 3**).
- Instant Message (IM) function: Sending and receiving of

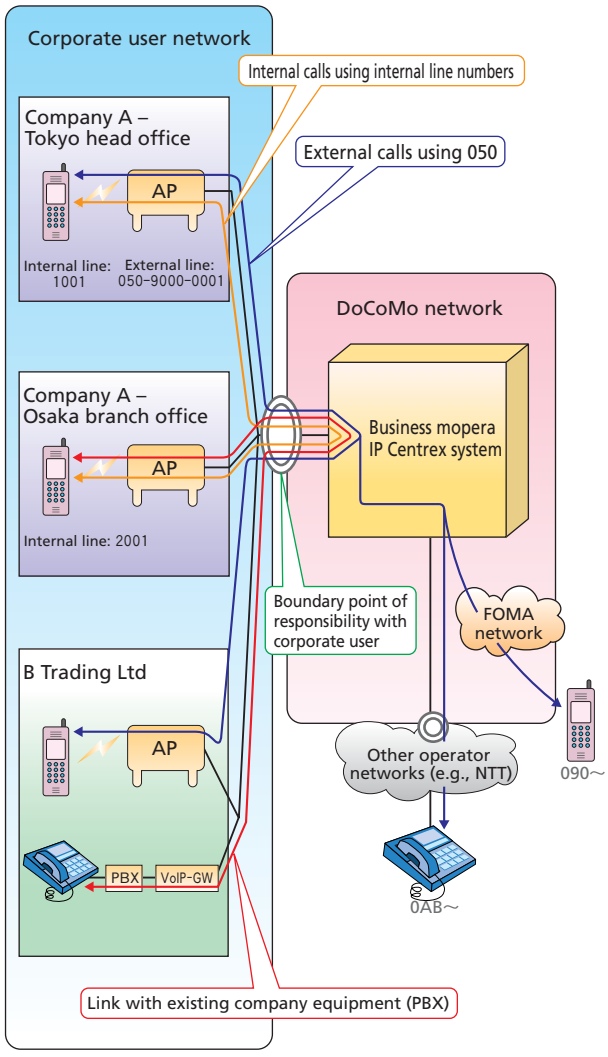
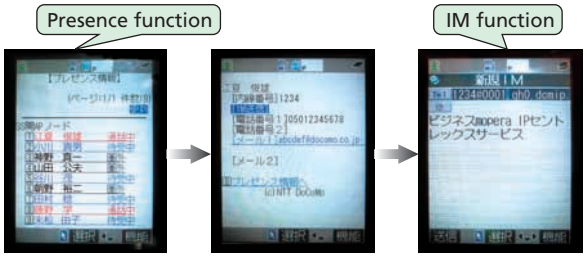


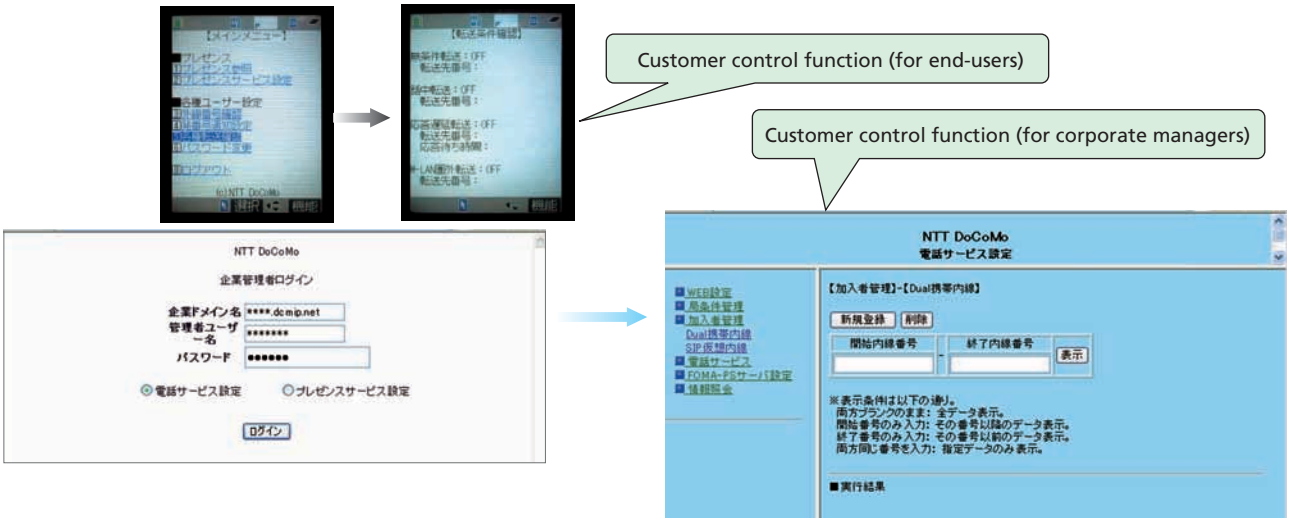
Figure 2 Calls on internal and external lines



(Names on the terminal screens are for illustration purposes only, and do not represent actual individuals.)
*This function is provided only in Japanese at present.

Figure 3 Presence and IM function screens

*2 Call park: A function used to hold a received call without disconnecting, and for talking on another phone belonging to the same group.
*3 Call hunting: A function used to select and receive calls on a phone on an internal line not in use for calls within the group, when a call is received at a preset main number.



*This function is provided only in Japanese at present.

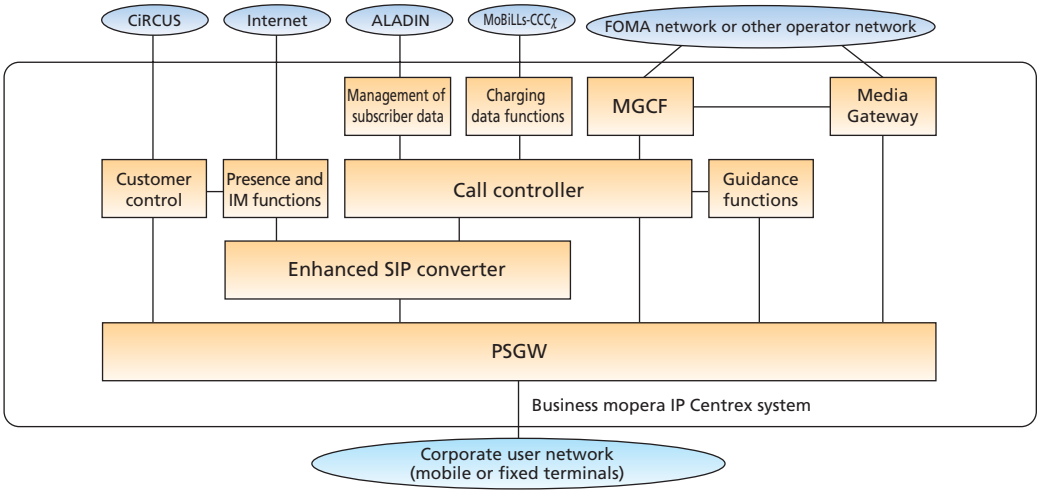
Figure 4 Customer control function screens

IMs, and sending of emails, as appropriate to presence status (Fig.3).

- Customer control functions: Controlling the setting of supplementary user services via a Web interface (for corporate managers and end-users) (**Figure 4**).

3. System Configuration

Figure 5 shows the business mopera IP Centrex system configuration, **Table 1** shows the major functions, and **Figure 6** shows the basic sequence and protocol stack. The example shows a call originating from a wireless LAN terminal that is received by a mobile terminal in the FOMA network. The loca-



ALADIN: ALl Around DoCoMo INformation systems
CiRCUS: treasure Casket of i-mode service, high Reliability platform for CUStomer
MoBiLLs-CCCχ: Mobile communication BiLLing systems-Customer CDR Collector for X

Figure 5 Business mopera IP Centrex system configuration

Table 1 Major functions of Business mopera IP Centrex system

Functions	Overview
Call control	Performs call control for internal and external lines, and evaluates various additional services.
Enhanced SIP conversion	Converts an enhanced SIP signal to a standard SIP signal during communication via an enhanced SIP terminal.
PSGW	Converts addresses within control signals and voice data packets.
Guidance	Provides various types of guidance.
MGCF	Performs the conversion of exchange signal protocol (SS7) and business mopera IP Centrex system signal protocol (SIP) signals for call setup with exchanges.
Media Gateway	Performs the physical conversion of the exchange transmission interface (STM) and business mopera IP Centrex system transmission interface (IP) for voice communication with exchanges.
Presence and IM	Manages and changes the presence status of wireless LAN terminals, and sends and receives IM.
Subscriber data management	Receives information from ALADIN and manages subscriber data.
Charging data	Transfers the charging information to MoBiLLs-CCC χ.
Customer control	Manages items to be set for terminals (e.g., internal line numbers) by accessing from wireless LAN terminals or FOMA terminals.

STM: Synchronous Transport Module

tion of the wireless LAN terminal has already been registered.

Call setting uses SIP in the business mopera IP Centrex system (or Media Gateway Control Function (MGCF) from the wireless LAN terminal), and ISDN User Part (ISUP)[*4] in connection to the FOMA network. However, the gateway to the FOMA network is separated into a MGCF handling the Control-Plane (C-Plane)[*5] and a Media Gateway handling the User-Plane (U-Plane)[*6]. Business mopera IP Centrex system calls and FOMA network calls are therefore synchronized and connected using MEdia GAteway COntrol (MEGACO)[*7] with instructions issued from the MGCF to the Media Gateway. When the INVITE signal is sent from the wireless LAN terminal, the signal is terminated in the enhanced SIP converter that converts enhanced SIP to standard SIP. When the INVITE signal arrives at the MGCF, a call is established using the FOMA network and ISUP. Finally, the wireless LAN terminal is called and transits to call-received status, then the communication is established.

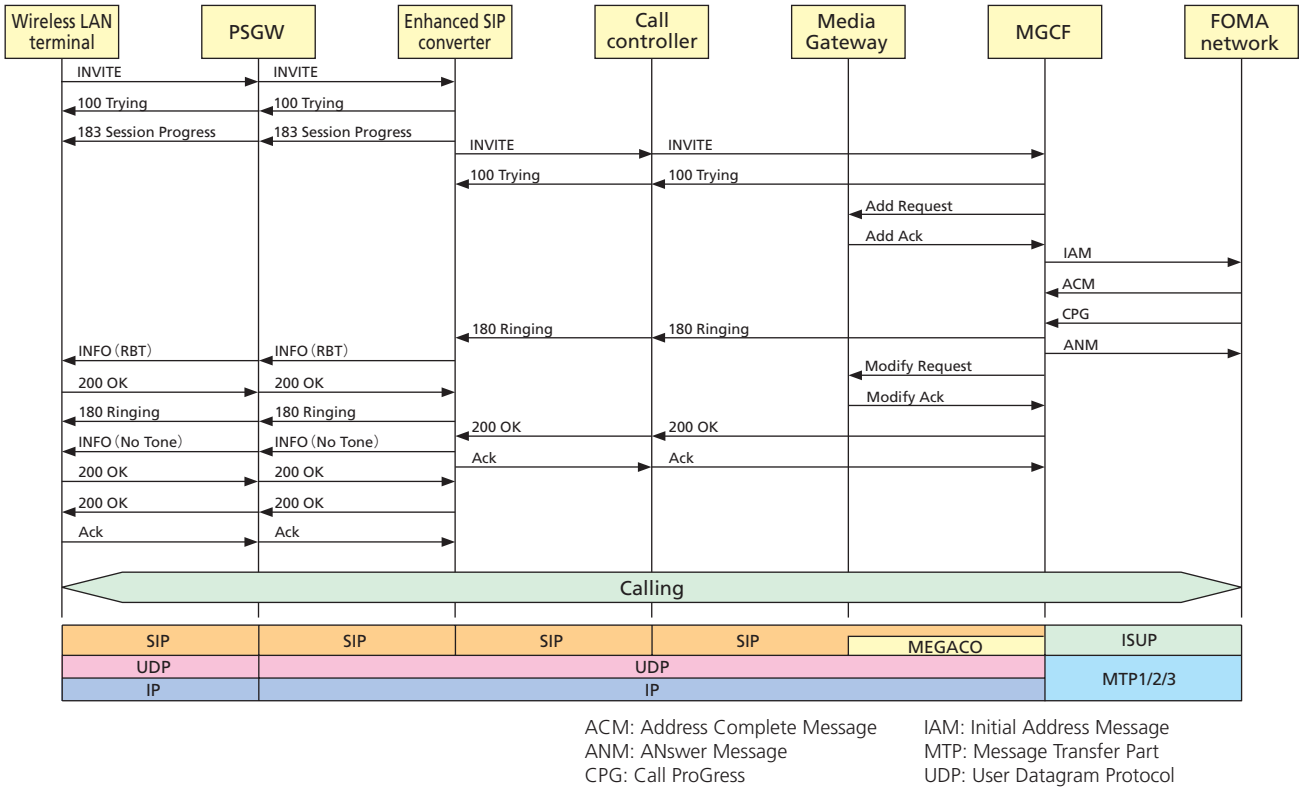


Figure 6 Basic sequence and protocol stack

*4 ISUP: Part of the Signaling System No.7. A protocol used for control of public switched telephone networks, and handles connection processing in ISDN.
*5 C-Plane: A section handling the end-to-end sending and receiving of call control signals.

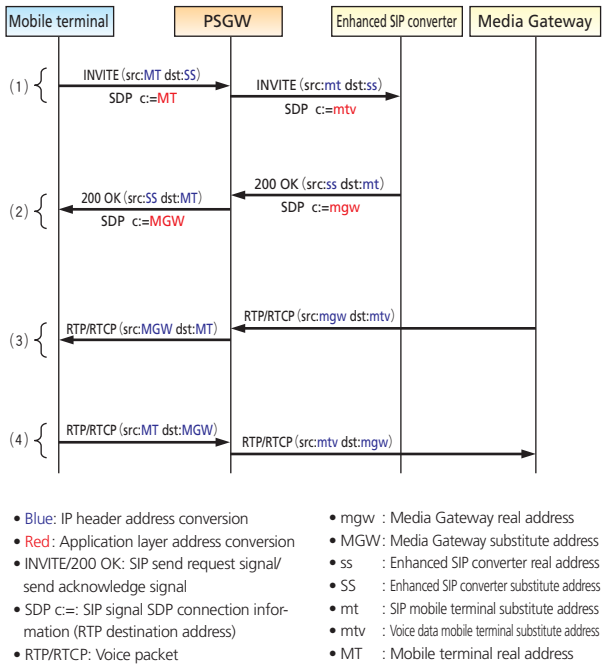


Figure 7 Address conversion in basic sending sequence

4. Developed Functions

The following functions have been developed to provide the business mopera IP Centrex service.

4.1 Conversion of IP Addresses

The ability of the user to build the desired network at each site with private addresses implies the possible duplication of inter-site network addresses, and of site network and DoCoMo network addresses. This duplication is avoided in the business mopera IP Centrex system by installing a Packet Switch GateWay (PSGW) between the DoCoMo network and sites, and running Network Address Translation (NAT)[*8]. The PSGW runs NAT for a diverse range of signal applications (SIP, Domain Name System (DNS)[*9], HTTP, Real-time Transport Protocol (RTP)[*10], and RTP Control Protocol (RTCP)[*11]). Ingenuities involved in SIP and RTP/RTCP are described below.

SIP signals require the establishment of an IP address in the application layer. It is therefore not possible to establish calls solely with normal NAT in which only the IP address of the IP header is converted in the PSGW. To resolve this problem, NAT is also required in the PSGW for Session Description Protocol (SDP) connection information, etc. that is set for the RTP/RTCP destination by SIP application. **Figure 7** shows address conversion in the basic call sequence for Public Switched Telephone Networks (PSTN). IP header address conversion (src/dst) and application layer address conversion (SDP c:) are run for SIP signals; only IP header address conversion (src/dst) is run for RTP/RTCP. Here, DoCoMo network addresses are shown in lowercase and corporate addresses in uppercase. The IP header addresses for SIP signals are converted by using a preset table so as to maintain the distinction, for example, between MT and mt, and SS and ss. The application layer SDP connection information is created dynamically from a preset IP address band for MT and mtv, and MGW and mgw. RTP/RTCP is sent to an address previously reported in the SDP connection information; that is, to addresses mtv and MT reported in the INVITE signal (Fig. 7 (1)) SDP connection information, RTP/RTCP (Fig. 7 (3)) is sent from the Media Gateway in the mobile terminal direction. RTP/RTCP (Fig. 7 (4)) is sent from the mobile terminal in the Media Gateway direction to addresses MGW and mgw reported in the SDP connection information for the 200 OK signal (Fig. 7 (2)) in response to the INVITE signal. Thus, RTP/RTCP IP header address conversion is based on the prior SDP connection information address conversion.

NAT is changed in the PSGW with the connection pattern for the relevant call (**Figure 8**). A call is identified as intra-site communication on an internal line (Fig. 8 (1)), or as inter-site communication on an internal line (Fig. 8 (2))/external line (Fig. 8 (3)). For intra-site communication on an internal line, SDP connection information is controlled so that voice data is not drawn into the DoCoMo network. NAT is able to handle correspondence between uppercase and lowercase characters. The SIP signal is sent and received by the mobile terminal and the enhanced SIP converter with either connection pattern. The INVITE signal sent from the mobile terminal on the site network to the enhanced SIP converter on the DoCoMo network, and the INVITE signal returned from the controller and sent

*6 U-Plane: A section handling the end-to-end sending and receiving of user data.
*7 MEGACO: A gateway function used for connecting telephone transit networks and IP networks with IP phones.
*8 NAT: Conversion of packet IP addresses within two independent networks.
*9 DNS: A system that associates host names and IP addresses on IP networks.
*10 RTP: A communications protocol used for the real-time distribution of voice and video streaming data.
*11 RTCP: A communications protocol for the exchanging data reception status from a streaming server and the control of transmission rates, etc. Used in combination with RTP.

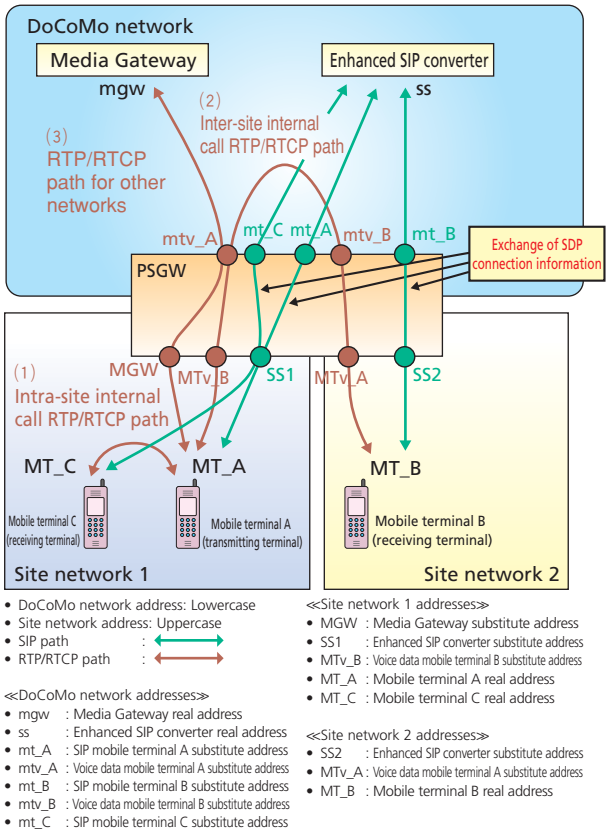


Figure 8 PSGW NAT

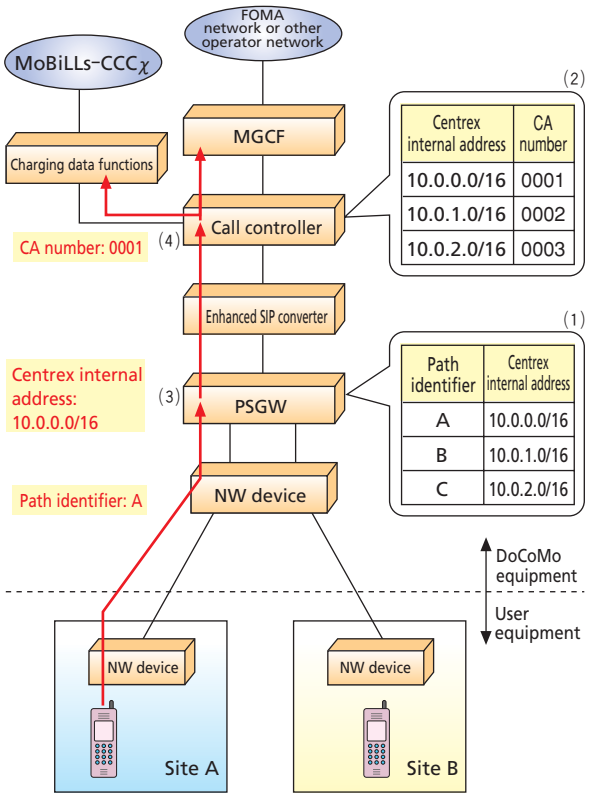


Figure 9 Derivation of CA information

from the enhanced SIP converter to the mobile terminal are recognized as signals related to the same call based on the fact that the SDP connection information is the same. When both INVITE signals are for the same site, the call is identified as intra-site communication on an internal line. When the two signals differ, the call is identified as inter-site communication on an internal line or an external line.

When mobile terminal A is identified as communicating intra-site on an internal line, the SDP connection information is converted to a mobile terminal address (MT_A/MT_C). Thus, RTP/RTCP is restricted to the site network (Fig. 8 (1)). Conversely, with communication on an external line, each path is controlled through the PSGW (Fig. 8 (3) since the SDP connection information is converted to the Media Gateway substitute address MGW in the PSGW. Similarly, with inter-site communications, the path is controlled via the PSGW (Fig. 8 (2)) by converting SDP connection information to the voice data mobile terminal B substitute address MTv_B on the PSGW site network 1.

In addition to the SDP connection information, parameters in which the IP address is set exist in the SIP application layer. Similar NAT is also run for these parameters.

4.2 Derivation of CA Information

When the communication involves calls from a mobile terminal to a fixed network, as is the case with conventional mobile communications, IP Centrex, as an operator, must issue charging details to which Charge Area (CA) information is added. However, with the business mopera IP Centrex service, in which user information is centralized and where DoCoMo does not own the equipment installed at user sites, accurate CA information for mobile terminals in use cannot be acquired or identified.

With the method adopted for the business mopera IP

Centrex, CA information is therefore generated from information on the IP network and used in identifying the calling location of the mobile terminal (**Figure 9**). The derivation of CA information for a calling mobile terminal is explained below in detail.

- A table associating path identifiers (Virtual LAN (VLAN) number – a logical identifier) in access circuits between each user site and the business mopera IP Centrex gateway server (PSGW), and network addresses used in the business mopera IP Centrex network is created in the PSGW (Fig. 9 (1)).
- A table associating the aforementioned network addresses used in the DoCoMo network and corresponding CA information is created in the call controller (Fig. 9 (2)).
- When a call is made on a mobile terminal from the user site, the relevant path identifier is converted to a network address used in the corresponding DoCoMo network (Fig. 9 (3)) in the PSGW.
- The network address used in the DoCoMo network is then converted to corresponding CA information in the call controller (Fig. 9 (4)).

Another method of deriving CA information involves the acquisition of such information as the Media Access Control (MAC) address[*12] for the user site's equipment-dependant Access Point (AP) and determination of the calling mobile terminal area based on this MAC address information. This method has a number of disadvantages, such as the need to acquire information on the AP (user equipment) and the need for re-registration whenever the mobile terminal is moved (i.e., the connection AP is changed).

Conversely, with the current method, the work required of IP Centrex is limited to creating the aforementioned correspondence table when the user contracts the service (Fig. 9 (1) and (2)), thus simplifying the acquisition and management of CA information. Even if the mobile terminal at site A is moved to site B, neither the business mopera IP Centrex nor the user site is subject to any changes, and it is possible to determine that the relevant mobile terminal is calling from site B.

5. Conclusion

This article has described the supported functions, system configuration, and developed functions for the business mopera IP Centrex service.

Following the launch of the service, further improvements in functions and the enhancement of Fixed Mobile Convergence (FMC) are scheduled for the future.

*12 MAC address: A 12-digit fixed physical address allocated to an Ethernet board.