Special Articles on IP-based RAN for Economical and Flexible Network Construction

Base Station–Data Transfer Module

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To provide the OFFICEED in-house calling service for corporate use, we developed the BS-DTM, equipment for transferring data between base stations utilizing the routing flexibility of IP-based RAN.

1. Introduction

OFFICEED is a service for corporate use that provides in-house calling between FOMA terminals within an OFFICEED area. The concept of the OFFICEED service is shown in **Figure 1**. The OFFICEED area is supported by an In-building Mobile Communication System (IMCS)[*1] which is composed of IP-Base Transceiver Station (IP-BTS), compact indoor IP base stations. To make OFFICEED service available to everyone within a group, the group representative is required to register the FOMA terminals of the group in advance. Dialing "*55+(cell phone number)" gives access to flat-rate voice and Audio-Visual (AV) calling between registered FOMA terminals. If the receiving party is outside the OFFICEED area, the call can still be received with the OFFICEED transfer function. When using the OFFICEED transfer function, the charges for a transferred call are made on a pay-per-use basis. Upon user request, this function can be turned on/off.

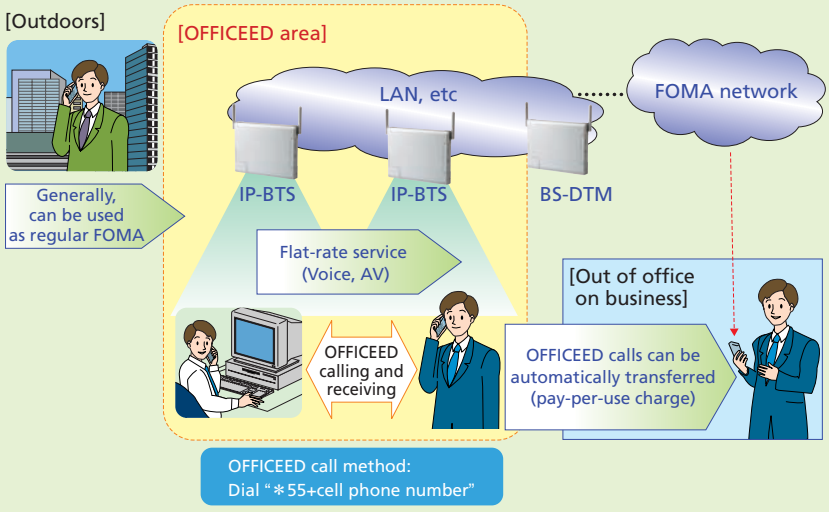

Figure 1 OFFICEED service concept

The OFFICEED service does not require a dedicated terminal. The OFFICEED users can enjoy the service with their own FOMA terminals. Therefore, the OFFICEED service increases user convenience.

For the realization of the service, we developed Base Station-Data Transfer Module (BS-DTM), an essential component for the OFFICEED service.

In this article, we describe the purposes, features, and technology of BS-DTM.

2. Development Purpose and Features of the BS-DTM

In the conventional Asynchronous Transfer Mode (ATM)[*2] based network, the user-data connection between the calling party and the receiving party is made

*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 **ATM**: A communication scheme in which fixed-length frames called cells are transferred successively.

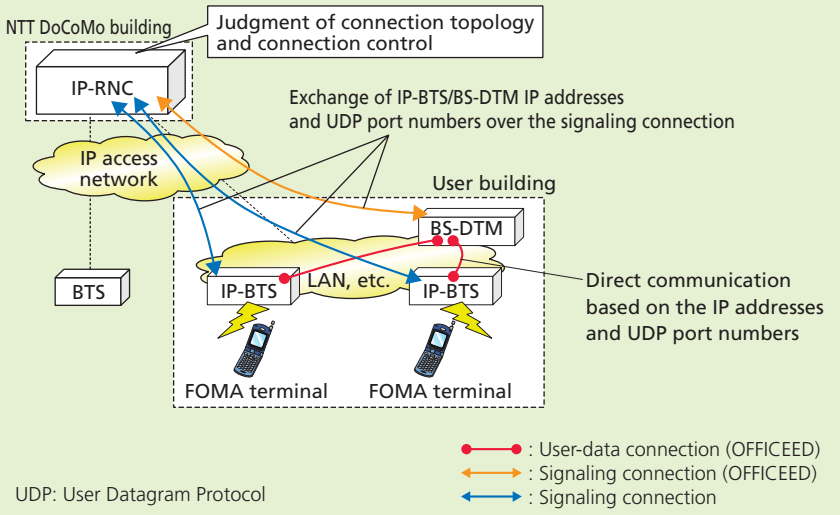

Figure 2 IP-based RAN network configuration and relationship between signaling connection / user-data connection

Photo 1 External view of BS-DTM

Table 1 Basic specifications of BS-DTM

Number of simultaneous calls	80 calls (equivalent to 160 terminals simultaneous voice calls)
Dimensions	W437×H88×D345 mm (2 units of 19-inch rack)
Weight	Approx. 6 kg
Communication interface	100Base-TX×1

via a switch in the NTT DoCoMo building.

The IP-based Radio Access Network (IP-based RAN) provides a more flexible routing than does the ATM-based network. The user-data connection between the calling and the receiving parties can be made within the user building premises, rather than through an upper-level switch, by installing a BS-DTM, which is located in the user building and has a function for transferring voice data and AV data between IP-BTSs. In this way, no user data flows over the transport path between the NTT DoCoMo building accommodating the switch and IP-Radio Network Controller (IP-RNC), and the user building accommodating the IP-BTS and BS-DTM. This architecture reduces the transport path cost of the NTT DoCoMo network, and thus makes a flat-rate calling service possible. The network configuration of the IP-based RAN and the relation of the signaling connection and the user-data connection are shown in **Figure 2**.

In the IP-based RAN, diversity hand-over control[*3], transmission power control, and other such radio control functions are possessed by the IP-RNC. However, to transfer the user data back within the user building premises, those radio control functions must be located on the user premises. Therefore, the BS-DTM is installed in the user building to provide some of the IP-RNC radio control functions locally.

In other words, the connection control function conventionally implemented at the switch and some of the radio control functions of IP-RNC are physically separated out into the BS-DTM and controlled via the IP network.

3. Technical Overview

The external view of BS-DTM is shown in **Photo 1** and the basic specifications are shown in **Table 1**. Multiple BS-DTMs can be installed in a single user building for expansibility according to the number of users and the amount of traffic and for redundancy against hardware failure.

The main functions of BS-DTM are originating and receiving connection control, user-data selection combining and splitting, user-data ciphering, IP Security (IPSec)[*4] security function, transport channel synchronization control, outer-loop power control[*5], and a sound playing function (ring back tone and voice guidance). These functions are controlled from IP-RNC via a newly-defined protocol.

When a circuit-switched call is made, BS-DTM generates separate logical identifiers for the calling side and the receiving side according to instructions from the IP-RNC. It then establishes a link between the logical identifiers and configures the destination of the user-data frames according to instructions from the switch via the IP-RNC. The user-data plane is

*3 **Diversity hand-over control**: A control that selects the data from the cell that has the best radio wave conditions when the same radio signal is received by multiple cells.

*4 **IPSec**: A protocol for highly secure communication that involves encryption of IP packets and authentication.

thus transferred back at the BS-DTM.

For ordinary calls, user-data selection combining and splitting, user-data ciphering, and outer-loop power control are performed in IP-RNC, but for transfer-back calls within the user premises, those functions are executed within the BS-DTM according to instructions issued from the IP-RNC to the user-data selection combining and splitting module, user-data ciphering module, and outer-loop power control module of the BS-DTM.

Because BS-DTM is installed on the user premises, IPSec is mandatory for security between the BS-DTM and the IP-RNC.

BS-DTM is also equipped with a transport channel synchronization control function to re-establish synchronization when synchronization is lost between the BS-DTM and the IP-BTS in cases of a user-data plane setup or a change of the network environment.

Placement of the sound playing function at BS-DTM is one of the distinctive features of the system. For an ordinary call, the ring-back tone and voice guidance are played back from the switching system, but for transfer-back calls, the sound playing module within the BS-DTM operates according to instructions from the switch via the IP-RNC and transmits the sound to FOMA terminals.

With those functions, it is possible to transfer the user-data connection back at BS-DTM without any change in the conventional control functions with respect to IP-BTS and the FOMA terminal.

4. Conclusion

We described OFFICEED, a new service that applies the features of the IP-based RAN in the FOMA network. We also explained the objectives, features, and functions of the newly-developed BS-DTM. The OFFICEED service established the foundation for in-house solutions provided by the FOMA system. In future work, we will continue the development to improve the user convenience of the OFFICEED service.

*5 **Outer-loop power control**: A power control in which the target uplink Signal-to-Interference Ratio (SIR) of the closed-loop power control is controlled so as to maintain the target uplink quality.