FMC FOMA IP-phone

Technology Reports

Core Network System for Implementation of One Number Service

As part of efforts to improve the usability of IP-phone services from NTT DOCOMO, we have developed a system for providing the One Number service, which automatically selects a domain for receiving the call based on presence information for corresponding numbers on the FOMA and IP-phone networks, when a call is made to a FOMA number.

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1. Introduction

With the spread of IP-based networks, many new services such as VoIP are appearing, and recently there is increasing interest in services related to Fixed-Mobile Convergence (FMC)[*1]. All mobile phone operators have begun offering corporate FMC services that allow fixed-line and internal calls to be made from one mobile terminal.

However, whether corporate user or consumer, it has been assumed that the mobile numbers (090/080) and IP-phone numbers (050) used by many users would be handled separately. For example, to answer a call made to a mobile terminal with an IP-phone, a call forwarding service must be used, and forwarding charges will apply. Even with terminals that contain both mobile phone and IP-phone functions, two numbers are required for a single terminal (090/080 and 050), and these numbers are handled separately.

Accordingly NTT DOCOMO is providing the One Number service, which uses terminals like the "onefone" FOMA/WLAN dual terminal (FOMA N906iL)[1] that are able to operate as a mobile terminal supporting the FOMA area out-of-doors, and as an IP-phone when inside. The service allows calls to be initiated and received using a single, primary number, whether in the FOMA area or the IP-phone area. Note that in light of a report from the Number Study Group sponsored by the Ministry of Internal Affairs and Communications (a group studying policy for telecommunications numbers in the IP age), and considering the level of recognition of mobile phone numbers, we have used 090/080 numbers as the primary number for this service.

In this article, we describe the system developed for the One Number service using FOMA and IP-phone ("Home U" [2] and "Business mopera IP Centrex" [3]), as well as some original components for Business mopera IP Centrex.

2. Overview of the One Number Service

A representation of the One Number service from NTT DOCOMO is shown in **Figure 1**, allowing calls to be received through a primary number via FOMA or IP-phone systems.

1) Calls to the Primary Number

The user is assigned a 090/080 FOMA number as well as a 050 IP-phone number. The 090/080 number is

*1 **FMC**: A form of service in which fixed-line and mobile communications services are merged, providing higher-added-value.

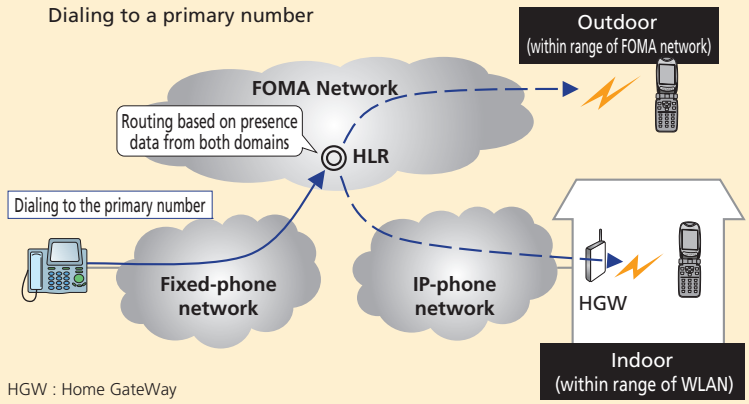

Figure 1 One Number connection

used as the primary number, and when a call is made to this number, it can be connected to either of the FOMA or IP-phone areas without any particular awareness of the networks where the receiver is currently available.

Earlier, when calling users with both FOMA and IP-phone contracts, the caller needed to be aware of the domain and corresponding number where the call would be received.

For example, even if the user was within both the FOMA and the IP-phone areas, when the 090/080 number was used to place the call, it would be connected through FOMA, and the IP-phone rates would not apply. Conversely, if the call was placed to the 050 number, in some cases the IP-phone rates would apply, but if the other party was not on the IP-phone network and unless they were using a forwarding service, the call would not connect.

With the introduction of the One Number service, if a call is placed to the primary number, it is connected through the IP-phone if possible, allowing increased use of the IP-phone without having to notify callers of the 050 number, and also increasing the rate of connection and efficiency of getting in contact.

2) Notification Number Settings (Dial Pad Operation)

In addition to allowing calls to be made to the primary number, the notification number can also be set. Earlier, when a call was originated from the IP-phone, the receiver was notified using the 050 number, but it is now possible for each user to set whether the receiver should be notified with the 050 number or the 090 / 080 primary number.

Through the functions in 1) and 2), it is possible to use only the primary number, without requiring any particular awareness of which of the IP-phone or FOMA network is being used.

3. Service Implementation

3.1 Receiving-domain Selection Function

With the One Number service, users are assigned a 090 FOMA number, which is the primary number, and a 050 IP-phone number. When the primary number is dialed, the receiving domain is decided based on the domain pre-selected by the receiving user (either the FOMA network or the IP-phone network, and initialized to the IP-phone network by default) and whether they are currently present on either of these networks. The call is then connected through this domain. The function described here allows the receiving user to pre-select a preferred domain.

Selection of the receiving domain is made based on both the preferred domain selected ahead of time by the user through dial pad operations, and user's current presence status on each domain when the call is received. Regardless of the originating network, the receiving domain selection is done by the Home Location Register (HLR)[*2] and the Home Subscriber Server (HSS)[*3].

When a call to the primary number is made from an IP-phone, a request for user information is sent from the originating Call Session Control Function (CSCF)[*4] to the HSS (**Figure 2**). The HSS maintains information about the

*2 **HLR**: On the FOMA network, a node which maintains subscriber state information, including subscriber numbers and their location/presence information.

*3 **HSS**: On an IP-phone network, a node which maintains subscriber state information, including phone number and location/presence information.

*4 **CSCF**: A node which performs VoIP session control.

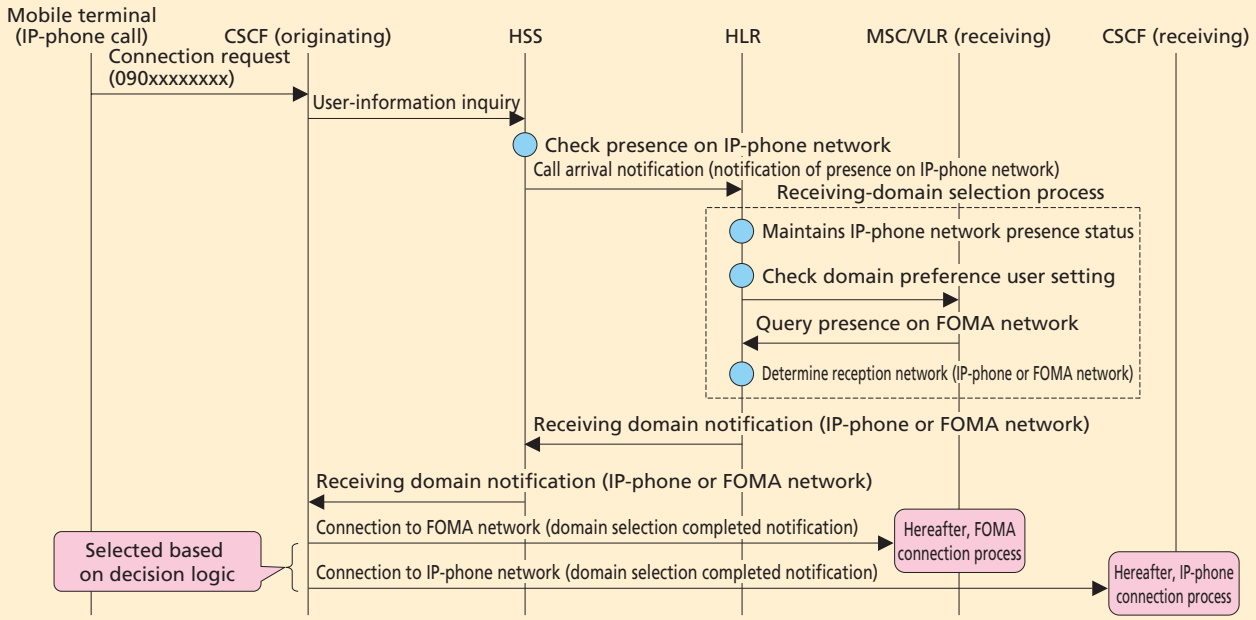

Figure 2 Sequence when dialing Home U primary number

receiver's presence on the IP-phone network and it sends a call-arrival notification to the HLR with this information. The HLR refers to the receiver's subscriber status for One Number and other potentially conflicting services to confirm whether the One Number service can be provided.

If the receiver is not a One Number subscriber, the call is connected through the FOMA network without selecting a receiving domain. If the current state allows the One Number service to be provided, the FOMA network presence status is requested from the receiving Visitor Location Register (VLR)[*5]. The domain to be used for the connection is selected using the preferred domain pre-set by the user, the IP-phone network presence notification from the HSS and the FOMA network presence status. When making the request to the receiving VLR, if the FOMA presence status stored in the HLR is already out-of-range (purge status), the receiver is determined not to be present on the FOMA network, and the request is not sent to the VLR. This decision logic is shown in **Table 1**.

After the receiving domain has been decided, the HLR notifies the HSS of the selected domain and the HSS, in turn, notifies the originating CSCF. The CSCF creates the connection to the domain indicated by the HSS in the same way as if the number in the receiving domain had been dialed directly. Any additional services (Nuisance Call Blocking service, Caller ID Notification service, etc.) are applied according to the conditions set in the receiving domain. In order to prevent the receiving domain selection function from being re-applied at this point, the receiving domain is notified that the connection is being made after completion of the domain selection process.

When a call to the primary number is dialed from the FOMA network, the HLR receives a request for user information from the originating Mobile-services Switching Center (MSC)[*6], and checks the user's One Number subscriber status in the same way as when calling from an IP-phone. If the user is a subscriber, the receiving-domain selection process is executed (**Figure 3**).

*5 **VLR**: On the FOMA network, a node which temporarily stores subscriber information.

*6 **MSC**: On the FOMA network, a node which performs call control and service control for providing mobile communications services.

First a request for the IP network presence status is sent to the HSS. Then a request for the FOMA network presence status is sent to the receiving VLR, the domain is selected based on presence information from both domains and the user's pre-set preferred domain, and the call is connected.

3.2 Originating Number Replacement Function

As described above, each subscriber to the One Number service is able to set the number that will be used for notification when a call is originated from the IP-phone network, either the primary number (090 / 080) or the IP-phone number (050). This is made possible by an "originating number replacement function" in the S-CSCF used when a FOMA/WLAN dual terminal registers its presence through Session Initiation Protocol (SIP)[*7] Registration[*8] (hereinafter reffered to as "originating S-CSCF").

Specifically, the originating S-CSCF maintains a profile for each user, and this new primary number and notification number is added to the profile for One Number service subscribers. If the primary number is to be used for notification, the originating S-CSCF sends a SIP INVITE message, replacing

Table 1 Preferred domain decision logic

Preferred domain	Presence on IP-phone network	Presence on FOMA network	Connection domain
IP-phone	○	—	IP-phone
IP-phone	×	○	FOMA
		×	IP-phone
FOMA	○	○	FOMA
		×	IP-phone
FOMA	×	—	FOMA

○ : Present on network
× : Not present on network
— : Regardless of status

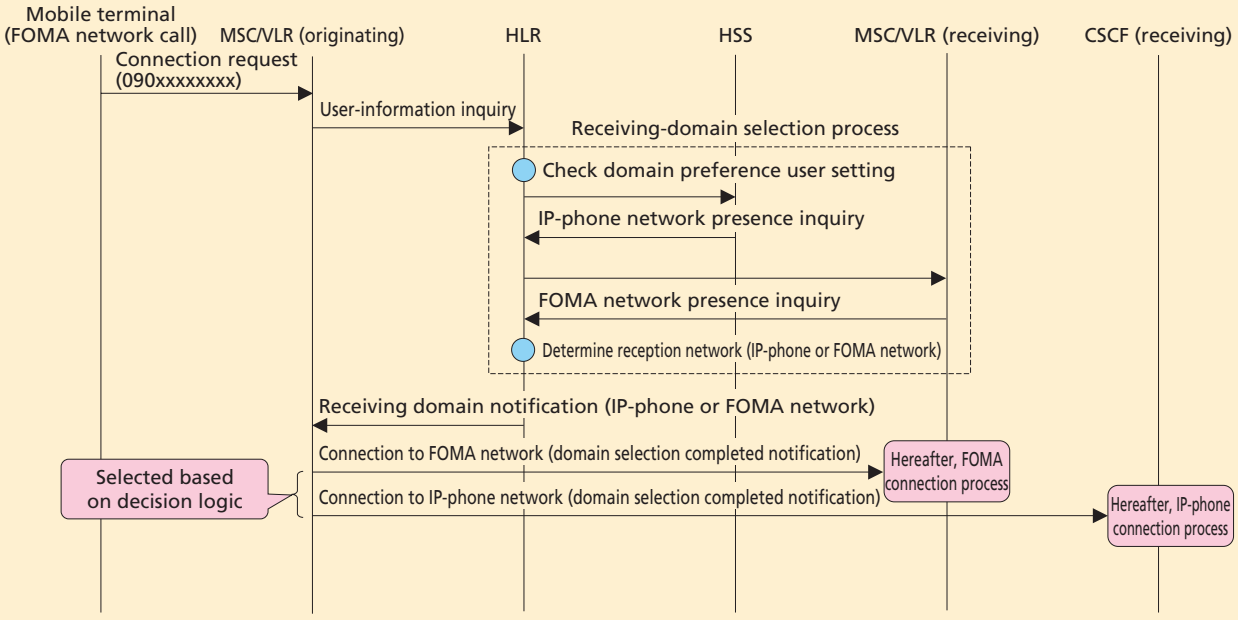

Figure 3 Sequence when dialing a FOMA primary number

*7 **SIP**: A call control protocol defined by the Internet Engineering Task Force (IETF) and used for IP-phone with VoIP, etc.
*8 **Registration**: On an IP-Phone network, when a mobile terminal uses SIP to register its current location information with an HSS.

the originating number part of the message with the primary number.

3.3 Originating Number, Receiving Network Notifications

As mentioned in Chapter 2, new calling and receiving functions are provided that allow users to select which of the numbers is used for notification, including an "originating number notification" function and an "enable receiving network notification" function.

The originating number setting allows the One Number subscriber to specify which number is used to notify the called party. Normally, the 090/080 primary number is used, whether the call originates from the IP-phone or the FOMA, but the user can also set it so that the 050 number is used. If the 050 number is selected, the originating number replacement function described in Section 3.2 is activated.

The receiving network notification function is a function which plays a short message directly after dialing, indicating that the call is being made through the IP-phone network, if that is the case when a call is placed to the primary number of a One Number subscriber. This function is initially set not to provide notification, since it would effectively notify the originator of the receiver's network presence.

Both of these settings can be changed using a dial pad operation. The receiving network notification setting can be changed by dialing 15482, and originating number notification by dialing 15483. As with existing dial pad operations that are used to change settings, the HLR implements these functions are by changing subscriber information that it maintains when the number is dialed.

4. Applying the One Number Service to the Business mopera IP Centrex Service

In order to provide the One Number service together with the Business mopera IP Centrex service, some original functions were implemented for Centrex in addition to the One Number systems described above, which are common to both the Home U and Business mopera IP Centrex services. An overview of the added functional components is shown in **Figure 4**.

- Maintaining the FOMA network user data on the Centrex network

A new Stream Control Transmission Protocol (SCTP)[*9] access component was added to the Centrex network, allowing it to access the HLR through the HSS to obtain in subscriber information that is stored on the HLR, including One Number and Nuisance Call Blocking service information and Caller ID Notification service information. When a profile is retrieved, it is maintained in the subscriber data management component of the Centrex network.

- Support for Nuisance Call Blocking and Caller ID Notification services.

With Business mopera IP Centrex, the Nuisance Call Blocking and Caller ID Notification services are only provided to users receiving the One Number service. A flag has been added to the header of the SIP

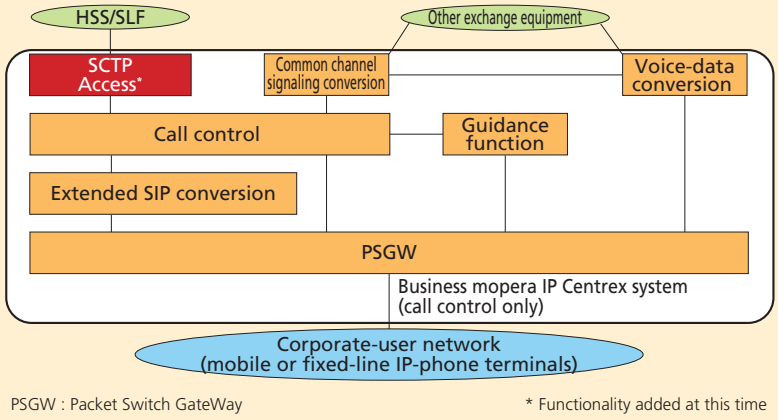

Figure 4 Business mopera IP Centrex system architecture

*9 **SCTP**: A transport-layer protocol created for forwarding telephone-network protocol over an IP network.

INVITE message received by the Centrex upon arrival. This flag indicates that a node performing One Number selection has selected the domain, FOMA network or IP-phone network, to which the call was forwarded. The Centrex network identifies this flag, and can then provide the service only to the applicable users.

- Addition of HLR subscription state

  The HLR maintains the subscription state for the Business mopera IP Centrex service, so that different services with respect to One Number determination can be offered for Home U and Centrex services.

- User fee processing for One Number calls

  When a Business mopera IP Centrex One Number user configures settings to send notifications with the primary number, the 090 number is used for notification, but when the Centrex places the call, the 050 number is included in the SIP INVITE message. This enables the fee processing systems reference the 050 number, and charge rates on a per-company basis.

5. Conclusion

In this article, we have described the One Number service for FOMA and IP-phone, its implementation, and application of this service to the Business mopera IP Centrex service. In the future, we plan to study ways to further expand the One Number service, such as a re-routing function that allows connection to different domains, even when the user temporarily goes out of range.

REFERENCES

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