ROAMING SERVICE FOR GSM SUBSCRIBERS IN CDMA NETWORK

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Abstract—This paper considers the method to provide the roaming service for GSM subscribers, who roam into the CDMA network. The roaming service basically requires the identification, authentication and location management of roaming subscribers in the visited network. It also requires the interrogation of subscriber’s data between the home and visited network. This paper proposes several requirements for the identification and authentication of GSM subscribers in the CDMA network. It also proposes the new type of location register as gateway node to the GSM network. Finally, it shows the examples of signaling information flow related to the roaming service.

1. INTRODUCTION

The one of main goals of 3rd generation mobile systems is to provide the global roaming service regardless of the type of visited network\(^1\). In the current standardization activity for 3rd generation mobile network, there are two types of mobile network evolved from the existing 2nd generations, such as CDMA and GSM. Thus, the roaming service between them becomes the most important subject to be solved\(^2\). The roaming service basically requires the identification, authentication and location management of the roaming subscriber in the visited network. Regarding the identification of subscribers, the currently released EIA/TIA specification, such as IS-95B, recommends that the mobile stations operating in CDMA mode are identified by the International Mobile Subscriber Identity(IMSI) based on ITU-T E.212\(^3\). Fortunately, the IMSI is also used for the GSM subscriber identification\(^4\). The figure 1 shows the comparison of main information elements used in the CDMA and the GSM network\(^3\|4\|5\|6\).
As depicted in figure 1, some information elements, such as TMSI and specially authentication data, have the different size and internal structure. This paper proposes several requirements for accommodating these GSM information elements in the CDMA network.

The roaming service also requires the interrogation of subscriber’s data. The interrogation needs the interworking between the home and visited network. This paper proposes the new type of location register as a gateway node to the GSM network, because the GSM network has the different MAP operations from the CDMA network.

This paper consists of following sections. The basic requirements for accommodating GSM subscribers in CDMA network are depicted in section 2, the examples of signaling information flow related to the roaming service are in section 3 and the conclusion in section 4.

2. BASIC REQUIREMENTS

This section describes some modification requirements of the existing CDMA network for basic roaming service.

2.1. The Accommodation of GSM SIM

In fact, it is generally impossible for a mobile terminal to directly roam into another network that has different radio environment. For that reason, the 3rd generation mobile system recommends the user mobility using the user identity module. The Subscriber Identity Module(SIM) in GSM already provided the user mobility to its subscribers. When a GSM subscriber roams into the other network operated in different radio environment, the subscriber inserts his SIM into the available mobile terminal in that area, and then tries to call or requests a service. Thus, the CDMA mobile terminal should accommodate the GSM SIM.
2.2. Variable Length of Authentication Data

The authentication of the subscriber roaming from another network is very sensitive and important matter. In current status, The CDMA and the GSM network use the different size of authentication data. When a GSM subscriber is authenticated in the CDMA network, the authentication data used for GSM subscriber can be transparently transferred among the mobile terminal and CDMA network entities (e.g., LR and AC). Thus, the CDMA network should redefine the authentication data (e.g., RAND, AUTHR) as it has variable length like digits parameter.

2.3. Storing and Transmitting TMSI Zone Information

In case of using Temporary Mobile Subscriber Identity (TMSI) in CDMA network, BS broadcasts a TMSI zone information in its service area. If a mobile terminal receives this information, it compares it with the zone information in its storage. If they are different, the mobile terminal initiates the location registration procedure with a full TMSI.

The full TMSI contains a TMSI code and TMSI zone information. The TMSI stored in GSM SIM is mapped on the only TMSI code in CDMA network. Thus, the CDMA mobile terminal should be able to store the previously broadcasted TMSI zone information temporarily. When the initiation of location registration procedure with a full TMSI is needed, the mobile terminal should be able to make the full TMSI by merging the TMSI code from SIM and the previous TMSI zone information.

2.4. Gateway Location Register

Gateway Location Register (GLR) was recommended for reducing signaling traffic between the home and visited network in 3GPP standardization activity. The GLR resides in visited network and acts as VLR for MAP signaling from the home network point of view. It also acts as HLR for MAP signaling from the visited network point of view.

The GLR proposed in this paper acts as GSM VLR from the GSM network point of view. It also acts as CDMA HLR from the CDMA network point of view. Figure 2 shows the logical network architecture including the GLR.
As depicted in figure 2, the GLR provides the interworking functionality between GSM HLR and CDMA VLR. Thus, it has the functionality to convert signaling message between CDMA and GSM MAP. The figure 3 shows the example of mapping relationship between CDMA and GSM MAP signaling message for the location registration [5][7]. The GLR also has the capability to temporarily store the subscriber's data, such as IMSI, LAI and authentication data and so on, received from the CDMA and GSM LRs.

<table>
<thead>
<tr>
<th>CDMA</th>
<th>GSM</th>
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<tbody>
<tr>
<td><strong>Message Name</strong></td>
<td><strong>Message Name</strong></td>
</tr>
<tr>
<td>Location Registration</td>
<td>Location Registration, Area</td>
</tr>
<tr>
<td>Notification req.ind.</td>
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<tr>
<td>Location Registration</td>
<td>Location Update, Location</td>
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<td>Notification req.ind.</td>
<td>Area</td>
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<td>Location Registration</td>
<td>Cancel Location</td>
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<td>Cancellation req.ind.</td>
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<td>Location Registration</td>
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Fig. 3. Example of mapping relationship

3. SIGNALING INFORMATION FLOW

This section describes the examples of signaling information flow related to the roaming service, when GSM subscribers roam into the CDMA network.

3.1. Initial Subscriber Identification Request

When a GSM subscriber roams into the CDMA network, the subscriber identification request procedure is initiated. The figure 4 shows the signaling information flow for the identification request of the GSM subscriber.
(A) If the CDMA mobile terminal detects the SIM of a GSM subscriber and the roaming of the subscriber in CDMA network, it makes the full TMSI with the TMSI code from SIM and a dummy TMSI zone information.

(B) If the MSC receives the location update message and decides that additional parameters (e.g., IMSI) are required, it sends the parameter request message to the VLR.

(C) If the VLR can’t recognize the previous VLR because the subscriber roams from the GSM network, it sends the failure report to the MSC.

(D) If the MSC detects the failure of parameter request procedure, it directly inquires the identification information (e.g., IMSI) to the mobile terminal.

3.2. Subscriber Authentication

As depicted in figure 1, the CDMA and the GSM network have the different-sized RAND and output of the authentication algorithm (AUTHR and SRES). Thus, it is impossible for the CDMA network to authenticate the GSM subscriber in its network by itself.

The CDMA network provides the auxiliary authentication procedure that is similar to the unique challenge mechanism in GSM. This paper proposes the subscriber authentication using the auxiliary procedure for the GSM subscriber. The figure 5 shows the signaling information flow for the GSM subscriber authentication.
3.3. Initial Location Registration

When a GSM subscriber roams into the CDMA network, the initial location registration procedure is initiated. The figure 6 shows the signaling information flow for initial location registration of the GSM subscriber.
Fig. 6. Initial location registration of GSM subscriber

(A) If the MSC receives the location update message, it initiates the subscriber identification request and authentication procedure if it is needed. It sends the registration notification message to the VLR.

(B) If the GLR receives the registration notification message from the VLR and detects that it has no available information of the subscriber, it makes the MAP_Update_Location message and sends it to the subscriber's HLR.

(C) The subscriber's HLR sends the MAP_Insert_Subscriber_Data message including the subscriber's profile and authentication data. And then, it returns the acknowledgement of the MAP_Update_Location message.

(D) If the GLR receives the subscriber's data from the HLR, it returns the acknowledgement of the registration notification message.

3.4. Location Update

When the GSM subscriber moves into the new VLR service area in CDMA network, the location update procedure is initiated. The figure 7 shows the signaling information flow for location update of the GSM subscriber.
(A) If the MSC receives the location update message, it initiates the subscriber identification request and authentication procedure if it is needed. It sends registration notification message to the VLR.

(B) If the GLR receives the registration notification message from the VLR and detects that the subscriber roams into the new VLR service area, the GLR sends the registration cancellation message to the old VLR.

(C) If the GLR receives the acknowledgement of the registration cancellation message from the old VLR, it returns the acknowledgement to the new VLR.

4. CONCLUSION

To satisfy the requirement of 3rd generation mobile system, global roaming, we need to consider the roaming service for GSM subscribers in the CDMA network that occupied the domestic market. For this purpose, this paper proposes several requirements for the identification and authentication of the GSM subscriber in the CDMA network. It also proposes the GLR concept for interworking to the GSM network. The GLR concept can be also respected to reduce the signaling traffic between the CDMA and the GSM network.
5. REFERENCES

[4] GSM 03.03, "Digital Cellular telecommunication system: Numbering, addressing and identification"
[7] GSM 09.02 v.6.0.0, "Mobile Application Part(MAP) specification".