3GPP TSG-CN Plenary **Tdoc NP-99105**
Yokohama, JAPAN
21st - 23rd April 1999

Title:	**Draft Technical Report: Gateway Location Register**
Source:	**NEC Technologies (UK),** **NEC Corporation** **NTT Mobile Communications Network Inc** **NTT Communication Ware Corporation** **Fujitsu Ltd** **Nippon Telecommunications Consulting**

This is the second draft of the technical report on the Gateway Location Register. This contribution is submitted for information only, it will be studied at the next TSG CN WG2 Sub Group B meeting (Tokyo, 27th-29th April)

1. Intellectual Property Rights
2. Foreword
3. Introduction

UMTS will build on the success of GSM and is likely to become even more widespread. IMT-2000 networks based on GSM evolution are planned for Europe, Japan, USA and Korea. Coupled with steadily increasing rates of international travel for business and leisure, this means a significant increase in the number of roaming users needing to be supported. This will lead to increased signalling traffic on "short -haul" and "long-haul" international links. The introduction of CAMEL Phase 3 for UMTS will add CAP signalling to these international links, leading to a further signalling load increase over present day levels.

The GLR (Gateway Location Register) is a node between the VLR and the HLR, which may be used to optimize the handling of subscriber profile data across network boundaries. The GLR is functionally part of the roaming subscriber's Home Environment. When a subscriber is roaming the GLR plays the role of the HLR towards the VLR in the visited network, and the role of the VLR towards the HLR in the home network. The GLR handles any location change between different VLR service areas in the visited network without involving the HLR. The GLR is an optional entity within the VPLMN operator's network.

4. Scope

This TR ~~will describe~~describes the use of a Gateway Location Register within the UMTS Core Network as a means of reducing the amount of MAP signalling traffic carried over international signalling links for roaming users.

5. References

6. Definitions and Abbreviations

6.1 Definitions

Gateway Location Register: This entity handles location management of roaming subscriber in visited network without involving HLR.
Interworking MSC: This entity is used as serving MSC towards home network and relay some messages between serving MSC and home network.

6.2 Abbreviations

GLR Gateway Location Register
IMSC Interworking MSC

7. Roaming Scenarios

The GLR is deployed at the edge of visited network. It contains roamer’s subscriber profile and location information, and handles mobility management within the visited network.

The subscriber information is downloaded from HLR to GLR at the first location update procedure under the GLR. Using the information, GLR handles *Update Location* message from VLR as if it is the HLR of the subscriber at second and further location updating procedures. GLR enables the procedure

invisible from the home network so that this hierarchical location management can reduce the inter-network signalling for the location management.

The GLR keeps the information until receiving *Cancel Location* message from HLR.

Figure 1 shows the general concept of GLR.

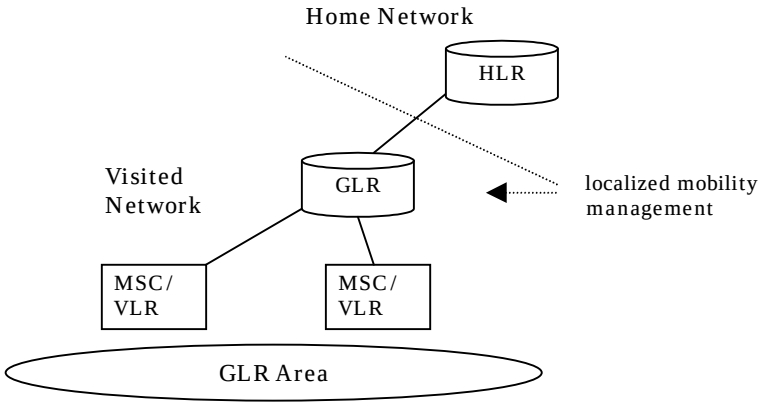

Figure 1 General Concept of GLR

8. Logical Network Model

GLR is logically located between HLR and ~~GLR as an option~~VLR as an optional node to optimise inter-network signalling for location management. ~~Overall~~The overall GLR concept is achieved by the GLR itself and Interworking-MSC (IMSC). The logical network model is shown in Figure 2.

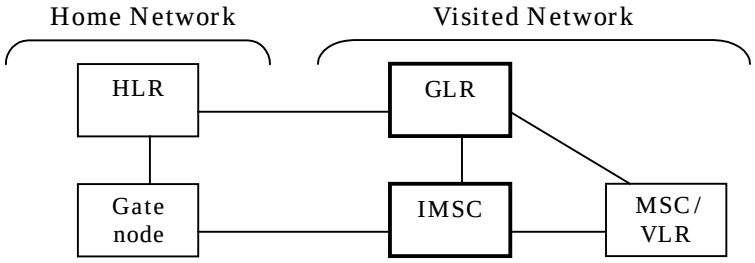

Figure 2 GLR Network Model

8.1 GLR

GLR is pseudo-HLR located in visited network. The roamer's information is stored in it and handles location management of it within the network. Presence of GLR is invisible from home network therefore interface between HLR and GLR is same as one of HLR and VLR.

8.2 IMSC

The Interworking MSC (IMSC) is the logical node, which represent MSCs in the visited network. Some service features use the MSC address stored in the HLR directly to deliver message from a certain node in home network (e.g. SMS-GMSC) to serving MSC in visited network. In such case, the message is

firstly distributed to representative MSC (i.e., IMSC) and it relays it to actual serving MSC interrogating routing information to GLR.

- The IMSC is a logical node which has a particular relationship with the GLR.
- The GLR alters the MSC Number to the IMSC Number within anUpdate Location message.
- The IMSC Number is the E.164 Number assigned to the IMSC.
- The interrogation function of the IMSC is similar to that in the SMS-GMSC.
- The IMSC may be implemented in the same type of physical node as that in which the GLR is implemented or that in which the MSC is implemented.

8.3 Gate Node

The Gate Node in Figure 2 represents, either a GMSC, GGSN, GMLC or SMS-GMSC.

9. Functional Description

9.1 Generic Functions

GLR is composed of several functions listed below.

9.1.1 Message Relay Functions

This function is used for the exchange of MAP operation between HLR and VLR via GLR. If a message is received from VLR(/HLR), the GLR identifies the relevant HLR(/VLR) using appropriate logic.

9.1.2 Address Conversion Function

In case of first location updating procedure under the GLR, *Update Location* message is passed to HLR replacing the VLR number and MSC address into GLR number and IMSC address so that the HLR can identify the appropriate GLR and IMSC.

9.1.3 Subscriber Information Caching Function

This function is to store the subscriber's information, which is obtained from HLR during location updating procedure. When the HLR send *Insert Subscriber Data* message to VLR via GLR for the first location update, the subscriber information is also stored in GLR and kept until it receives *Cancel Location* message from HLR. The stored information is used for HLR emulation Function.

9.1.4 Subscriber Information Cancellation Function

This function is to delete subscriber information stored in GLR and also in VLR as requested from HLR.

9.1.5 HLR emulation Function

This function is to handle the location management procedure only within the visited network. When it is decided that the request of location update can be handled at the GLR without involving HLR by Location Updating Screening Function, this function is invoked and GLR acts like the HLR of the subscriber.

9.1.6 Location Updating Screening Function

This function is used to judge, whether requested location updating is necessary to be indicated to HLR or not. This function is, for example, used such case that service logic in HLR is invoked when receiving the *Update Location* message from VLR.
[How screening function achieved needs further study.]

9.1.7 IMSC interworking Function

This function is used to provide routing information to Interworking MSC.

9.2 Circuit Switched Service

9.2.1 Location Update Procedure

In case of first location updating procedure in the network, this procedure is handled by HLR and VLR via GLR. For the second and further location updating, HLR is no longer involved with the procedure. The distinction of those two cases is controlled by GLR so that HLR and VLR is not necessary to be conscious of the difference.

9.2.1.1 First Location Updating

The first location updating procedure in a network is illustrated in Figure 3. Each step is explained in the following list.

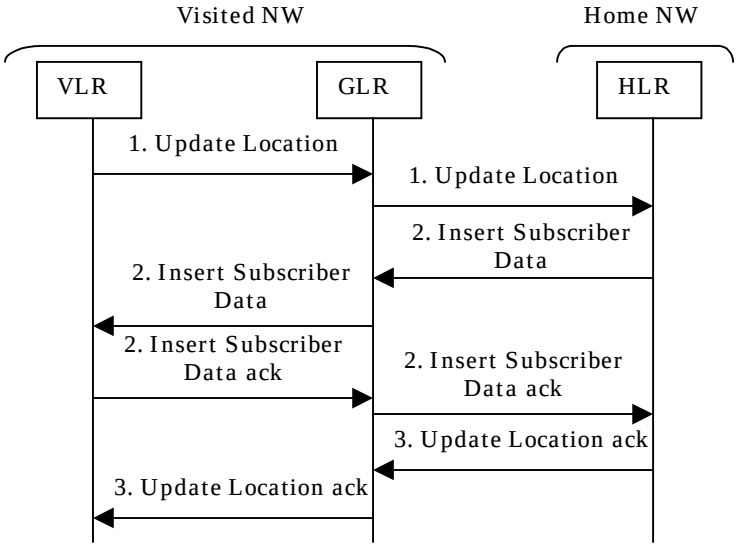

Figure 3 First Location Updating Procedure in the Network

Procedure:

1. When the GLR receives *Update Location* message from a VLR and does not hold the subscriber's information for the user (i.e. at first location update to the GLR), the GLR stores the VLR address and serving MSC address included in the received message and sends *Update Location* message to the HLR with the GLR address as *VLR number*, and IMSC address as *MSC address*.
2. The HLR stores the GLR address and IMSC address from received message as respectively VLR address and serving MSC address. Thereafter the HLR initiates insert subscriber data procedure and cancel location procedure. When the GLR receives *Insert Subscriber Data* message from the HLR, the GLR stores the subscriber's information in the message and transport it to the VLR.
3. After these procedures, the HLR replies to *Update Location* message from the GLR, and the GLR transports the response to the VLR.

9.2.1.2 Second and further Location Updating

The second and further location updating procedure in the network is illustrated in Figure 4. Each step is explained in the following list.

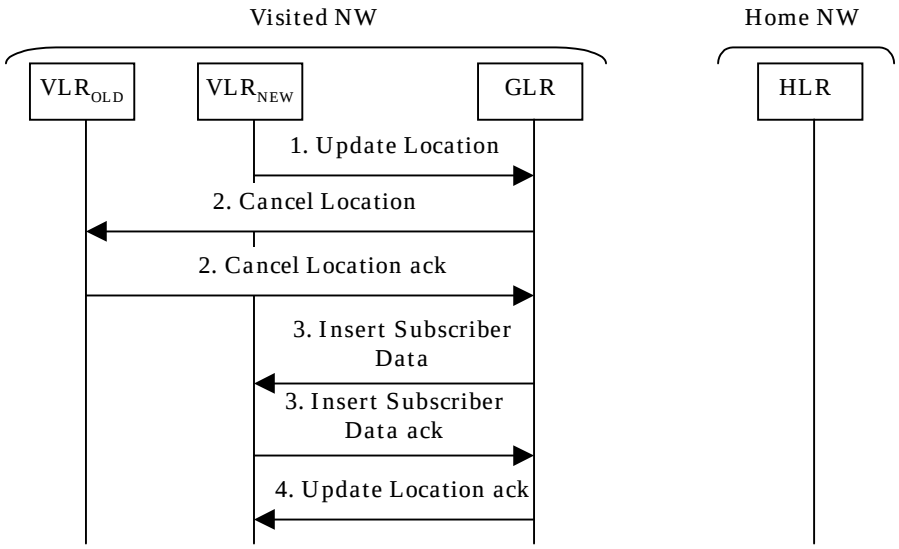

Figure 4 Second and further Location Updating Procedure in the Network

Procedure:

1. When the GLR receives *Update Location* message from newly visited VLR and holds the subscriber information for the user(i.e. at second or further location update to the GLR), the GLR stores the new VLR address and new serving MSC address included in the received message.
2. Thereafter the GLR initiates insert subscriber data procedure and cancel location procedure.
3. After these procedures, the GLR replies to *Update Location* message from the VLR.

9.2.1.3 Cancel Location

The cancel location procedure in the network when MS leave the network is illustrated in Figure 5. Each step is explained in the following list.

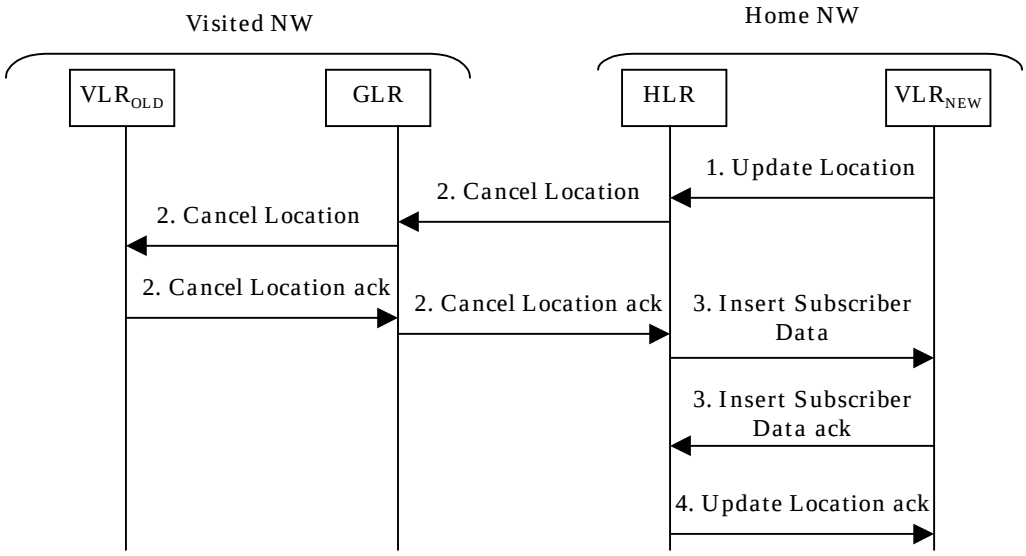

Figure 5 Cancel Location Procedure in the Network

Procedure:

1. When the HLR receives *Update Location* message from newly visited VLR after the MS left the network with the GLR, the HLR initiates cancel location procedure to the GLR.
2. The GLR receives *Cancel Location* message from the HLR and transport to the previously visited VLR. When the GLR receives the response, the GLR transports it to the HLR and restores the roamer's subscriber profile and location information.
3. The HLR initiates insert subscriber data procedure to the newly visited VLR.
4. After the procedure, the HLR returns the response of *Update Location* message to the newly visited VLR.

9.2.2 Routing Information Interrogation Procedure

The Routing Information Interrogation procedure is illustrated in Figure 6. Each step is explained in the following list.

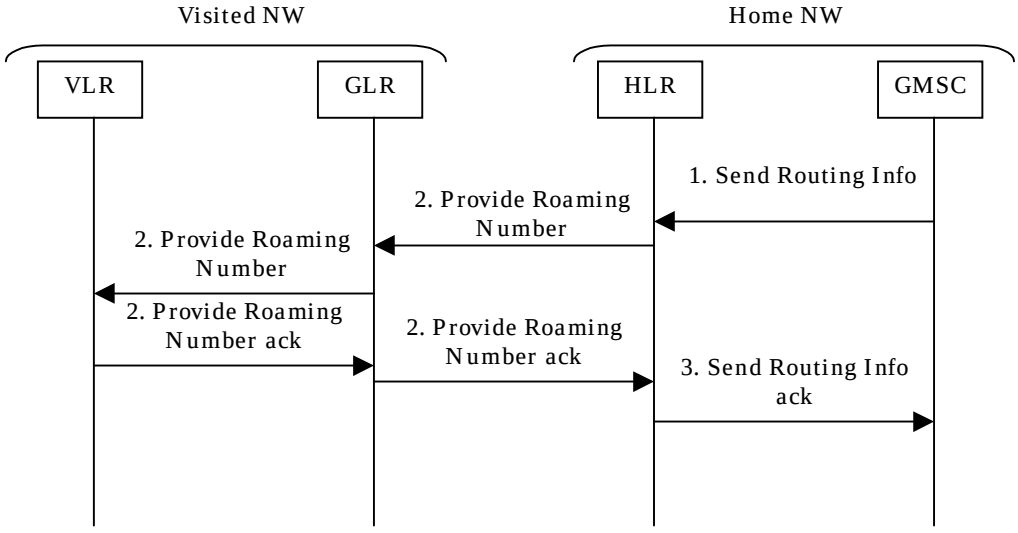

Figure 6 Routing Information Interrogation Procedure

Procedure:

1. When the HLR receives *Send Routing Info* message from the GMSC, the HLR sends *Provide Roaming Number* message to the GLR address stored as VLR address in order to interrogate the roaming subscriber's routing information.
2. The GLR transports the received message to the VLR. When the GLR receives the response with routing information for the user from the VLR, it transports to the HLR.
3. Thereafter the HLR notifies GMSC of the roaming subscriber's routing information by the response of *Send Routing Info* message.

9.2.3 ~~Supplementary Service Procedure~~Procedure for GSM/UMTS Message Delivery

~~Necessary~~The necessary functionality for the GLR to support ~~SS~~the transfer of MAP messages between the HLR and VLR is categorised as follows:

a) to relay message~~s~~ transparently between HLR and VLR,
b) to support ~~SS~~messages that directly uses the MSC address stored in the HLR and
c) to support ~~SS that requires~~messages that require a location update request to the HLR to invoke~~certain~~ service logic.

9.2.3.1 Transparent~~SS~~ message Relay (type a)

~~This type of capability is applied to most of the supplementary services that simply exchange message between HLR and VLR.~~

This describes the case where the GLR does not modify or interact with the MAP messages it relays between the HLR and VLR.

9.2.3.2 Message delivery using MSC address (type b)

Some ~~supplementary service use MSC address for the direct deliver of a message to MSC. To solve the situation, IMSC is introduced to handle the delivered message once in the visited network, and it is relayed to actual service MSC interrogating GLR.~~HLR originated messages use the MSC address stored in the HLR for the direct delivery of that message to the VMSC. However, because of the GLR's involvment, the VMSC address stored in the HLR is not updated as the roaming subscriber changes Location Areas. Therefore the VMSC address held in the HLR may no longer be valid.

To solve this situation, the IMSC is introduced into the visted network. The GLR modifies the Update Location messages to ensure that it is the IMSC address that is stored in the HLR instead of the visited MSC address. On receiving a type (b) message from the HLR, it is the function of the IMSC to request the VMSC address from the GLR.and then forward the message to the VMSC.
The procedure is illustrated in Figure 7.

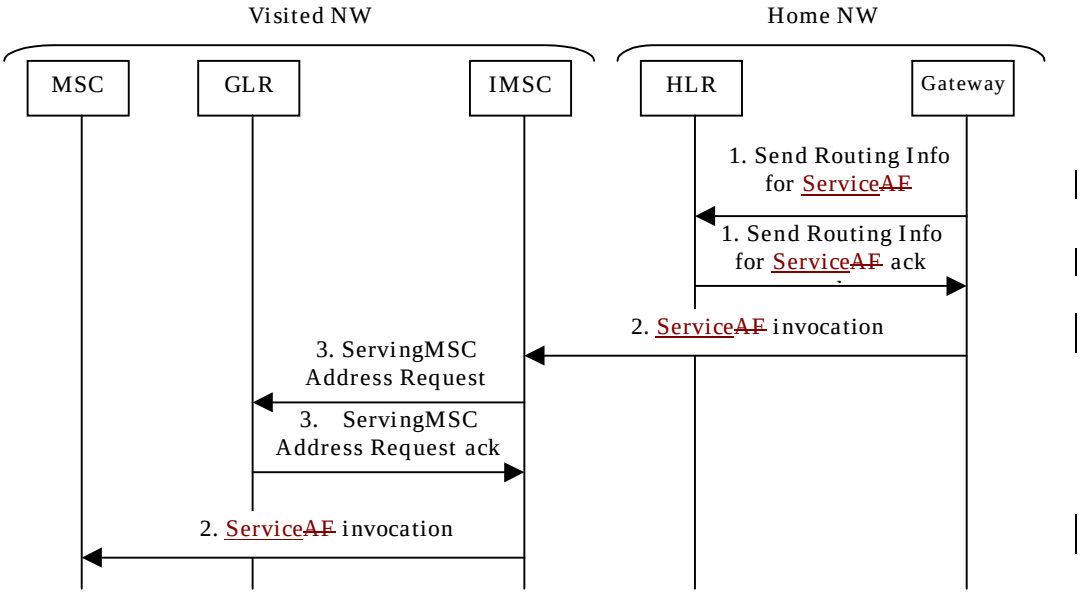

Figure 7 ~~SS~~ Delivery using MSC address

Note: Operation in Figure 7 is described in generic manner. They will be replaced by appropriate operation according to the situation.

Procedure:

1. When the HLR is interrogated from the Gateway about routing information for the ~~user to execute some SS,~~user, the HLR returns a response with the IMSC address held as serving MSC address at first location update.
2. Gateway sends ~~SS~~the invocation message to the IMSC using the IMSC address obtained from the HLR.
3. IMSC interrogates the GLR for the serving MSC address (by specifying the IMSI/LMSI that was included in ~~SS~~the invocation message from ~~Gateway.~~the Gateway).
4. After obtaining the serving MSC address, the IMSC sends ~~SS~~the invocation message to ~~MSC in order to initiate the SS.~~the MSC.

~~Example of supplementary service categorised in this type is shown in~~As an example of this type of message delivery, consider the LCS (Location Service) shown in the ANNEX.

9.2.3.3 Location Updating Screening (type c)

This procedure is required for the ~~supplementary service that will invoke service logic in HLR triggered by location updating procedure.~~cases where the location updating procedure will trigger service logic in the HLR. To support this category of service, the GLR need~~location updating procedure from HLR.~~ s to selectively screen the location updating procedure from the HLR. As an example, consider the CCBS supplementary service, which is illustrated in Annex 1.

The procedure is illustrated in Figure 8.

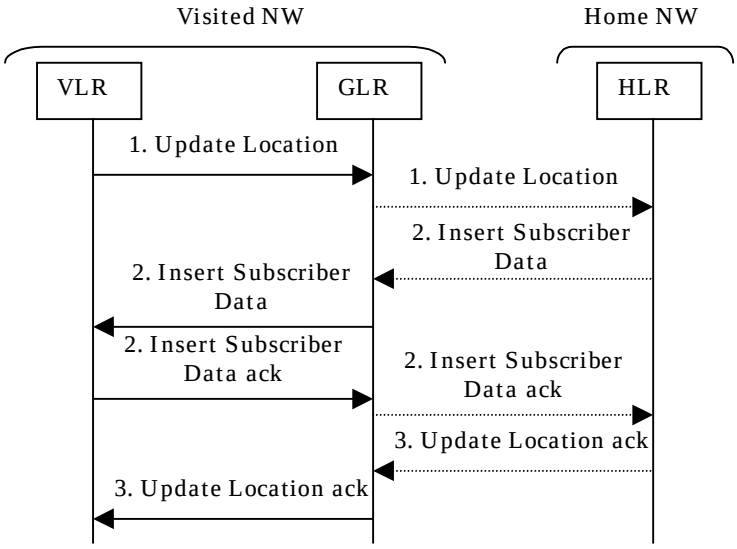

Figure 8 Location Updating Screening

Screening Information setting procedure is needed for the screening function. This procedure required further study.

~~Example of supplementary service categorised in this type is shown in ANNEX~~

9.3 Packet Switched Service

If GLR is introduced in Packet Service and manages mobility in visited network, GGSN cannot know the newest SGSN. To solve this problem, Interworking GSN like IMSC would be needed.
The detail procedure is for further study.

9.4 Common Procedures

9.4.1 Authentication Information Retrieval Procedure

The GLR does not cache authentication information so that the procedure is transparent to GLR (i.e., the GLR just relays the message). A study of whether the GLR will benefit from buffering authentication messages is outside the scope of this report.

9.4.2 Purge MS

The Purge MS procedure is illustrated in Figure 9. Each step is explained in the following list.(The procedure in the packet switched mode is similar to one in the circuit switched case)

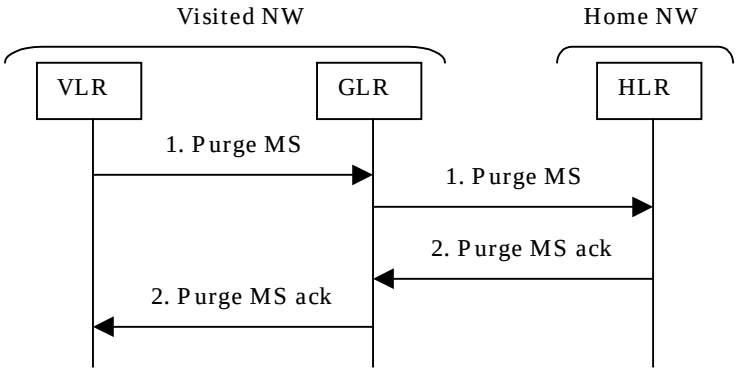

Figure 9 Purge MS procedure for circuit switched case

Procedure:

1. When the GLR receives *Purge MS* message from the VLR, the GLR transports the message to the HLR transparently. After the HLR sets MS purged flag for the MS, the HLR sends *Purge MS* response message.
2. When the GLR receives *Purge MS* response message, the GLR deletes the subscriber record for the MS and transports the *Purge MS* response message to the VLR.

9.4.3 Restart

Restart procedures can be categorised in following 3 cases. The existing procedures may be applied to each case. However details need further study.

9.4.3.1 HLR Failure

9.4.3.2 VLR Failure

9.4.3.3 GLR Failure

9.5 Short Message Service

SMS (Short Message Service) can be excuted using same method as message delivery type b~~SS~~ (refer to section Message delivery using MSC address (type b)). The sequence flow diagram of SMS in the network that contains the GLR is shown in **Figure 10**

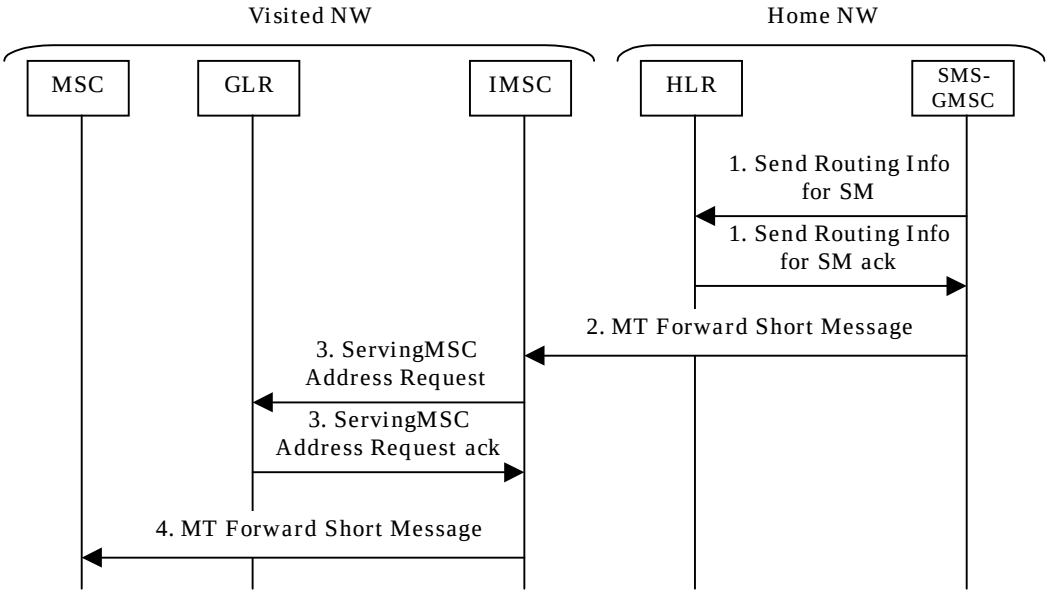

Figure 10 Short Message Delivery

~~9.6 SoLSA~~

~~Updating of the subscriber's LSA information by using SMS can be executed using same method as SMS (i.e. as type b SS in section 9.2.3.2).~~

10. Targets for MAP traffic optimisation

10.1 Location Update

The sequence flow diagram of Location Update between different VLR service areas in the visited network is shown in Figure 11. The case that the network does not contain the GLR is shown in part *a, and the case that the network contains the GLR is shown in part *b.

Introducing GLR at visited network, 6 messages, *Update Location, Cancel Location, Insert Subscriber Data* and their acknowledgements, are reduced at inter-network per one Location Update.

Using following parameters, amount of traffic of inter-network signalling related to update location can represent xyz*8/3600(bps)

x : average number of location updates for each roaming subscriber per one hour
y : average number of roaming subscribers
z (bytes) : average amount of bytes within the 6 messages of one location update

Example values of these parameters are as follows:

x = 1.25 (LU in one hour per roaming subscriber)
y = 100000(roaming subscribers)
z = 1000(bytes per LU sequence)

In this case, the amount of reduction of inter-network signalling by introduction of GLR is about 278kbps.

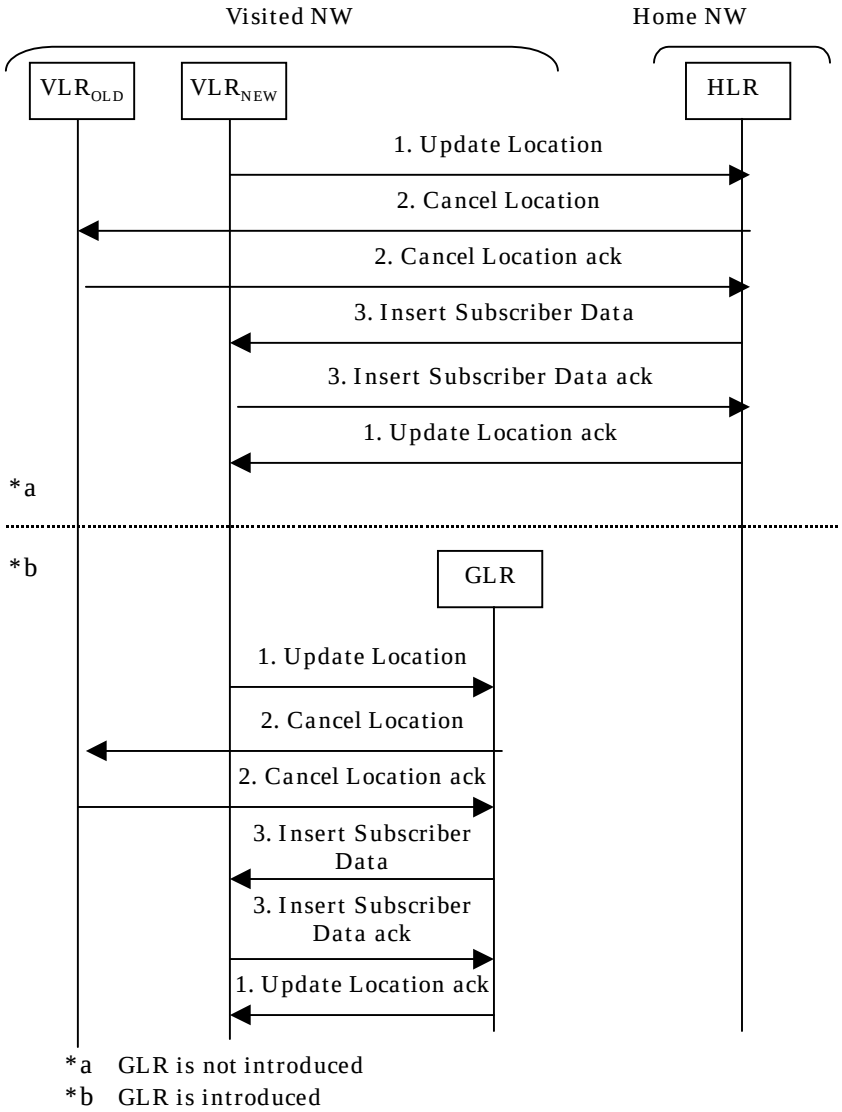

Figure 11 Location Update Procedure with/without GLR

11. Compatibility of GLR with GSM Release 98

In order to standardise GLR, it would be necessary to modify some standards in the visited network. These specifications are at least as follows:

GSM 09.02 MAP
GSM 03.40 SMS

12. Impact on GSM Release 99 Specifications

[Editor's Note: This describes the detailed changes required in GSM Release 99 to implement the GLR].

13. Conclusions

ANNEX

14. ~~Example of Supplementary Service Handling~~Examples of Message Handling by the GLR

14.1 Completion of calls to busy subscribers (CCBS)

In CCBS, certain service logic is initiated by receiving Location Update request. Therefore, CCBS is categorized as type c in Location Updating Screening (type c).
Subscriber A is the user of MS A requesting CCBS, and Subscriber B is the user of MS B, who is busy when first called by subscriber A.
Case 1):A-side
If Monitoring Subscriber A roams to visited network which contain the GLR, the GLR manages monitoring state of Subscriber A. If the A-side monitoring is ongoing when the GLR receives a Location Update request from the new VLR, the Location Update signal is relayed to the HLR to inform the appropriate CCBS process in the HLR.
Case 2):B-side
If Monitoring Subscriber B roams to visited network which contain the GLR, the GLR manages monitoring state of subscriber B. If the B-side monitoring is ongoing when the GLR receives a Location Update request from the new VLR, the normal mobility management procedures are followed by relaying Location Update request to HLR. On successful completion of Location Update procedure, the HLR shall send a Start Reporting signal to the new VLR via the GLR. However details need further study.

14.2 Location Service (LCS)

In LCS, the GMLC directly accesses to serving MSC interrogating MSC address to the HLR for Mobile terminating Location Request (MT-LR) and MT-LR for a previously obtained location estimate. Therefore LCS is categorized as type b in Message delivery using MSC address (type b).
Figure A1 illustrates sequence flow of MT-LR. Sequence flow of MT-LR for a previously obtained location estimate is same as MT-LR.

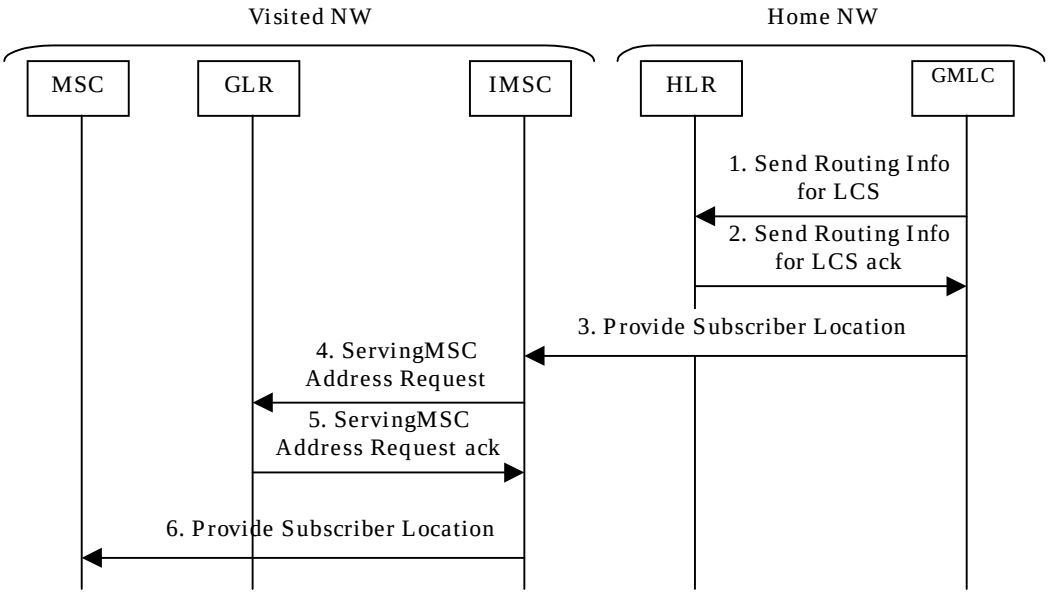

Figure A1 Mobile terminating Location Request

14.3 SMS Alert procedure

[Editor's Note: SMS Alert procedure may be initiated when HLR receives Update Location message. In GLR equipped network, as second and further Location Updating is screened by GLR, SMS Alert procedure cannot be initiated by HLR. Appropriate procedure should be defined to solve this problem.]