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**Source:** NEC  
**Title:** The percentage reduction of traffic due to the GLR  
**Version:** 0.0.2

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*This contribution is updated based upon the result of discussion in the TSG-N2 subgroup B meeting held in Tokyo.*

### 1. Introduction

This contribution introduces the benefit of the GLR by illustrating the percentage reduction of traffic due to the GLR.

It is proposed that the texts on sections 2 to 4 are included in the GLR Technical Report.

### 2. Variables

The variables to be used for traffic calculation are categorised based on the scenario defined as follows;

Variable	Scenario	# of MAP message (round trip)
$N_{ul}$	Location registration	3 (UL + CL +ISD)
$N_{mo}$	Mobile origination	0
$N_{mt}$	Mobile termination	1 (PRN)
$N_{sai}$	Authentication	1(SAI)
$N_{ss}$	SS related scenario (Register SS, Erase SS, Activate SS, Deactivate SS, etc)	Mostly 1 per scenario
$N_{ot}$	Other scenario that uses MAP signals between VLR and HLR (O&M related, Fault recovery related, etc)	Mostly 1 per scenario

The detail objects for each variable are tabulated in the Annex 1.

### 3. General assumptions

- The GLR covers one VPLMN.
- $N_{au} = N_{ul} + N_{mo} + N_{mt}$

**4. Traffic models**

**(a) Great City area**

**Assumptions**

1. In a great city like Tokyo, it can be assumed that 3 million mobile terminals in 600 square kilometres. Due to the capacity of a VLR and the trade-off between paging cost and location update cost, about 50 location areas in the 600 square kilometres are reasonable.
2. According to a dense subscriber and the capability of the VLR, it is assumed that one VLR covers only one location area in a great city.
3. The traffic to be investigated is that in the busy hour, e.g., rush in the evening. In the evening, people moves from the office or school to home, and we can suppose the moving distance is about 20 km on the average. It causes a lot of update location.
4. The number of triplet for SAI is 4.
5.  $N_{ss}$  and  $N_{ot}$  are negligible.

The following ratio can be supposed based upon the assumptions above.

- $N_{ul} : N_{mo} : N_{mt} : N_{sai} : N_{ss} : N_{ot} = 300 : 50 : 50 : 100 : 1 : 1$   
(The packet call is excluded in  $N_{mo}$  and  $N_{mt}$ )

According to the definition of variables in section 2 and message ratio assumed above, the following result is calculated as the percentage reduction of traffic due to the GLR.

In the case that the GLR is not deployed in the network, the number of MAP message per subscriber is calculated below;

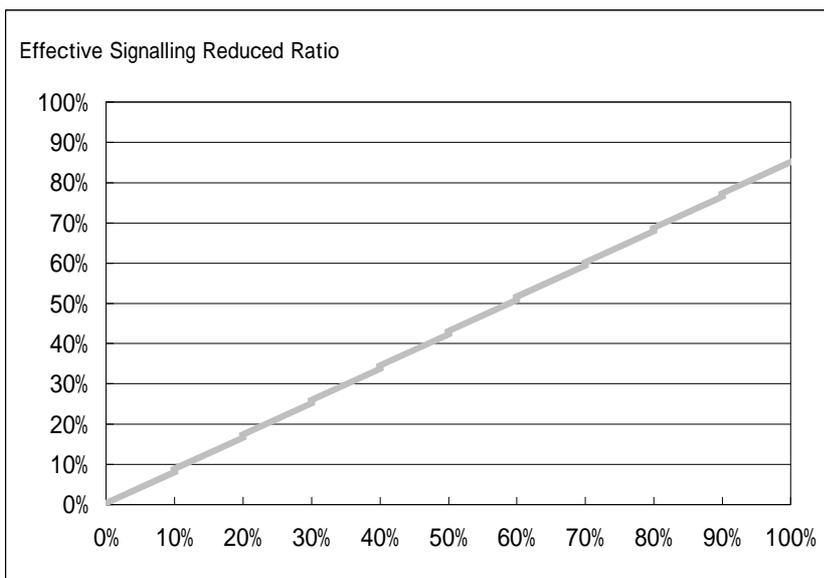
- $N_{ul} * 3 + N_{mo} * 0 + N_{mt} * 1 + N_{sai} * 1 + N_{ss} * 1 + N_{ot} * 1$

On the other hand, in the case that the GLR is deployed in the network, the number of MAP message per subscriber is calculated below;

- $N_{ul} * 0 + N_{mo} * 0 + N_{mt} * 1 + N_{sai} * 1 + N_{ss} * 1 + N_{ot} * 1$

According to the two expressions above, approximately 85% of the MAP message per subscriber can be saved due to the GLR when subscriber moves inside of the VPLMN.

Since the inter PLMN location update is not an object of the GLR at least release 99, the effective signalling reduction varies with the ratio of the location update signal (Intra PLMN : Inter PLMN). The following graph shows the percentage reduction of traffic due to the GLR that corresponding to the ratio of the location update signal (Intra PLMN : Inter PLMN). The horizontal axis is the ratio comparing intra PLMN location update and inters.



Location update ratio  
( Intra : Inter )

(b) **Urban area in Europe**

**Assumptions**

1. In a urban area in Europe, it can be assumed that 1 million mobile terminals in 600 square kilometres. Due to the capacity of a VLR and the trade-off between paging cost and location update cost, about 15 location areas in the 600 square kilometres are reasonable.
2. According to a dense subscriber and the capability of the VLR, it is assumed that one VLR covers only one location area.
3. The traffic to be investigated is that in the busy hour, e.g., rush in the evening. In the evening, people moves from the office or school to home, and we can suppose the moving distance is about 20 km on the average. It causes a lot of update location.
4. The triplet is always obtained from HLR every location update time. However, it is assumed that the call attempts always consume the triplet previously obtained at the location update time.
5. SS related message is relatively higher than Tokyo area.

The following ratio can be supposed based upon the assumptions above.

- $N_{ul} : N_{mo} : N_{mt} : N_{sai} : N_{ss} : N_{ot} = 100 : 50 : 50 : 100 : 10 : 1$   
(The packet call is excluded in  $N_{mo}$  and  $N_{mt}$ )

According to the definition of variables in section 2 and message ratio assumed above, the following result is calculated as the percentage reduction of traffic due to the GLR.

In the case that the GLR is not deployed in the network, the number of MAP message per subscriber is calculated below;

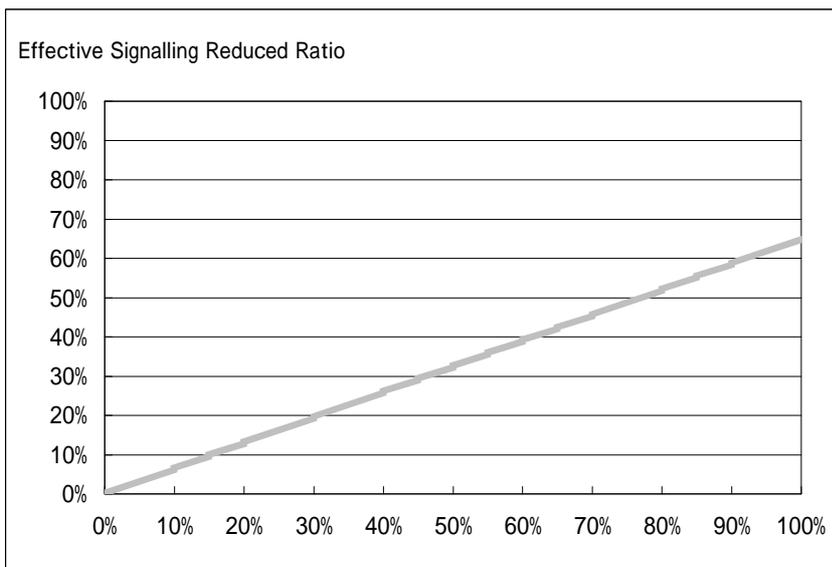
- $N_{ul} * 3 + N_{mo} * 0 + N_{mt} * 1 + N_{sai} * 1 + N_{ss} * 1 + N_{ot} * 1$

On the other hand, in the case that the GLR is deployed in the network, the number of MAP message per subscriber is calculated below;

- $N_{ul} * 0 + N_{mo} * 0 + N_{mt} * 1 + N_{sai} * 1 + N_{ss} * 1 + N_{ot} * 1$

According to the two expressions above, approximately 65% of the MAP message per subscriber can be saved due to the GLR when subscriber moves inside of the VPLMN.

Since the inter PLMN location update is not an object of the GLR at least release 99, the effective signalling reduction varies with the ratio of the location update signal (Intra PLMN : Inter PLMN). The following graph shows the percentage reduction of traffic due to the GLR that corresponding to the ratio of the location update signal (Intra PLMN : Inter PLMN). The horizontal axis is the ratio comparing intra PLMN location update and inters.

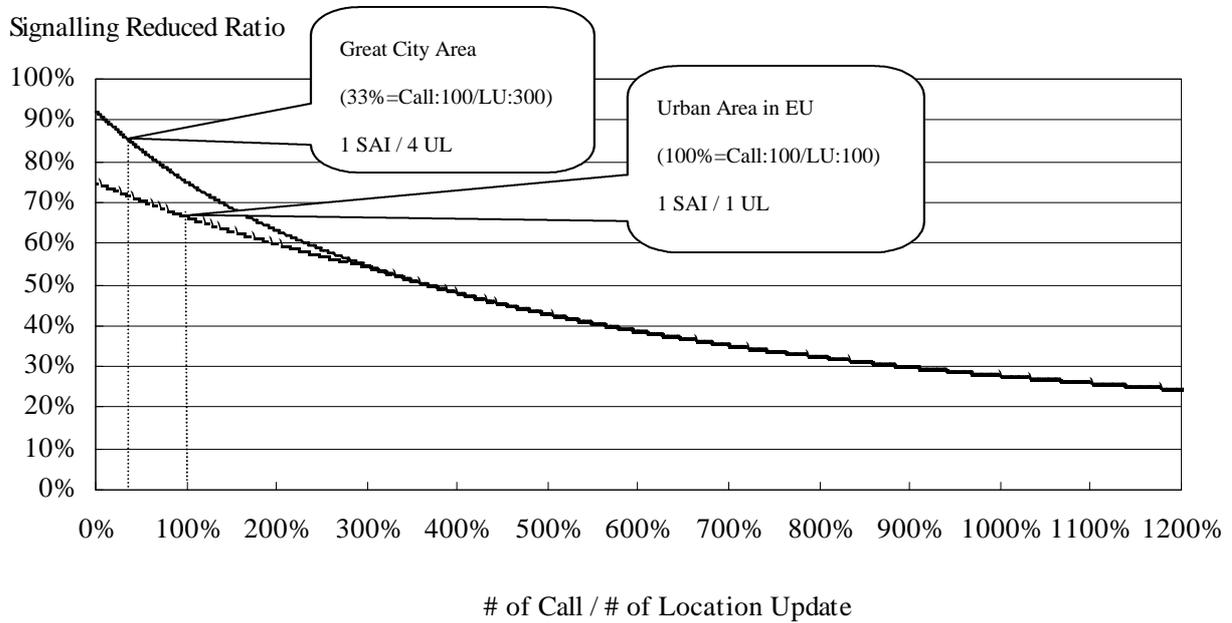


Location update ratio  
( Intra : Inter )

### (c) Relation to the call attempt

The following graph shows the percentage reduction of traffic due to the GLR that corresponding to the ratio between number of call attempt and number of location update.

For example, a 400% in the horizontal axis means that the average ratio of calls to location updates is 4 to 1. In this case, approximately 50 % of MAP signalling can be reduced due to the GLR.



### 5. Conclusions

- This contribution concludes that the deployment of the GLR enable to effectively reduce the signals between VLR and HLR since it is clarified that the mobility management signals have much impact to the MAP traffic between VLR and HLR as compared with call related signals (Origination/Termination call, SMS, etc).
- The effective signalling reduction can be expected not only in Great City like Tokyo but also in urban area in Europe.

# ANNEX 1

## MAP OPERATIONS

Category	Sub-category	MAP Operation	Between	Variable
Mobility services	Location management	MAP_UPDATE_LOCATION_AREA service	MSC-VLR	-
Mobility services	Location management	MAP_UPDATE_LOCATION service	VLR-HLR	N_UL
Mobility services	Location management	MAP_CANCEL_LOCATION service	HLR-VLR,HLR-SGSN	N_UL
Mobility services	Location management	MAP_SEND_IDENTIFICATION service	VLR-VLR	-
Mobility services	Location management	MAP_DETACH_IMSI service	MSC-VLR	-
Mobility services	Location management	MAP_PURGE_MS service	VLR-HLR,SGSN-HLR	N_OT
Mobility services	Location management	MAP_UPDATE_GPRS_LOCATION service	SGSN-HLR	-
Mobility services	Paging and search	MAP_PAGE service	VLR-MSC	-
Mobility services	Paging and search	MAP_SEARCH_FOR_MS service	VLR-MSC	-
Mobility services	Access management	MAP_PROCESS_ACCESS_REQUEST service	MSC-VLR	-
Mobility services	Handover services	MAP_PREPARE_HANDOVER service	MSC-MSC	-
Mobility services	Handover services	MAP_SEND_END_SIGNAL service	MSC-MSC	-
Mobility services	Handover services	MAP_PROCESS_ACCESS_SIGNALLING service	MSC-MSC	-
Mobility services	Handover services	MAP_FORWARD_ACCESS_SIGNALLING service	MSC-MSC	-
Mobility services	Handover services	MAP_PREPARE_SUBSEQUENT_HANDOVER service	MSC-MSC	-
Mobility services	Handover services	MAP_ALLOCATE_HANDOVER_NUMBER service	MSC-VLR	-
Mobility services	Handover services	MAP_SEND_HANDOVER_REPORT service	VLR-MSC	-
Mobility services	Authentication management	MAP_AUTHENTICATE service	VLR-MSC	-
Mobility services	Authentication management	MAP_SEND_AUTHENTICATION_INFO service	VLR-HLR	N_SAI
Mobility services	Authentication management	MAP_SET_CIPHERING_MODE service	VLR-MSC	-
Mobility services	International mobile equipment	MAP_CHECK_IMEI service	VLR-MSC,MSC-EIR,SGSN-EIR	-
Mobility services	International mobile equipment	MAP_OBTAIN_IMEI service	VLR-MSC	-
Mobility services	Subscriber management	MAP_INSERT-SUBSCRIBER-DATA service	HLR-VLR,HLR-SGSN	N_UL
Mobility services	Subscriber management	MAP-DELETE-SUBSCRIBER-DATA service	HLR-VLR,HLR-SGSN	N_OT
Mobility services	Identity management	MAP-PROVIDE-IMSI service	VLR-MSC	-
Mobility services	Identity management	MAP-FORWARD-NEW-TMSI service	VLR-MSC	-
Mobility services	Fault recovery services	MAP_RESET service	HLR-VLR,HLR-SGSN	N_OT
Mobility services	Fault recovery services	MAP_FORWARD_CHECK_SS_INDICATION service	HLR-VLR	N_OT
Mobility services	Fault recovery services	MAP_RESTORE_DATA service	VLR-HLR	N_OT
Mobility services	Subscriber Information	MAP-ANY-TIME-INTERROGATION service	gsmSCF-HLR	-
Mobility services	Subscriber Information	MAP-PROVIDE-SUBSCRIBER-Info service	VLR-HLR	N_OT
Operation and maintenance	Subscriber tracing services	MAP-ACTIVATE-TRACE-MODE service	HLR-VLR,HLR-SGSN	N_OT
Operation and maintenance	Subscriber tracing services	MAP-DEACTIVATE-TRACE-MODE service	VLR-HLR,SGSN-HLR	N_OT
Operation and maintenance	Subscriber tracing services	MAP-TRACE-SUBSCRIBER-ACTIVITY service	VLR-MSC	-
Operation and maintenance	Other operation and maintenance	MAP-SEND-IMSI service	VLR-HLR	N_OT
Call handling services		MAP_SEND_ROUTING_INFORMATION service	GatewayMSC-HLR	-
Call handling services		MAP_PROVIDE_ROAMING_NUMBER service	HLR-VLR	N_MT
Call handling services		MAP_RESUME_CALL_HANDLING service	terminating VMSC-GMSC	-
Call handling services		MAP_PREPARE_GROUP_CALL service	AnchorMSC-RelayMSC	-
Call handling services		MAP_PROCESS_GROUP_CALL_SIGNALLING service	RelayMSC-AnchorMSC	-
Call handling services		MAP_FORWARD_GROUP_CALL_SIGNALLING service	AnchorMSC-RelayMSC	-
Call handling services		MAP_SEND_GROUP_CALL_END_SIGNAL service	RelayMSC-AnchorMSC	-
Call handling services		MAP Provide SIWFS Number	MSC-SIWFS	-
Call handling services		MAP SIWFS Signalling Modify	MSC-SIWFS	-
Call handling services		MAP SET REPORTING STATE service	HLR-VLR	N_OT
Call handling services		MAP STATUS REPORT service	VLR-HLR	N_OT
Call handling services		MAP REMOTE USER FREE service	HLR-VLR	N_OT
Supplementary services related services		MAP REGISTER_SS service	MSC-VLR,VLR-HLR	N_SS
Supplementary services related services		MAP ERASE_SS service	MSC-VLR,VLR-HLR	N_SS
Supplementary services related services		MAP ACTIVATE_SS service	MSC-VLR,VLR-HLR	N_SS
Supplementary services related services		MAP DEACTIVATE_SS service	MSC-VLR,VLR-HLR	N_SS
Supplementary services related services		MAP INTERROGATE_SS service	MSC-VLR,VLR-HLR	N_SS
Supplementary services related services		MAP INVOKE_SS service	MSC-VLR	-
Supplementary services related services		MAP REGISTER_PASSWORD service	MSC-VLR,VLR-HLR	N_SS
Supplementary services related services		MAP GET_PASSWORD service	HLR-VLR,VLR-MSC	N_SS
Supplementary services related services		MAP_PROCESS_UNSTRUCTURED_SS_REQUEST service	MSC-VLR,VLR-HLR,HLR-gsmSCF	N_SS
Supplementary services related services		MAP_UNSTRUCTURED_SS_REQUEST service	gsmSCF-HLR,HLR-VLR,VLR-MSC	N_SS
Supplementary services related services		MAP_UNSTRUCTURED_SS_NOTIFY service	gsmSCF-HLR,HLR-VLR,VLR-MSC	N_SS
Supplementary services related services		MAP_SS_INVOCATION_NOTIFY	MSC-gsmSCF	-
Supplementary services related services		MAP REGISTER_CC_ENTRY service	MSC-VLR,VLR-HLR	N_SS
Supplementary services related services		MAP ERASE_CC_ENTRY service	MSC-VLR,VLR-HLR	N_SS
Short message service management services		MAP-SEND-ROUTING-INFO-FOR-SM service	GatewayMSC-HLR	-
Short message service management services		MAP-MO-FORWARD-SHORT-MESSAGE service	MSC-GatewayMSC,SGSN-Gate	-
Short message service management services		MAP-REPORT-SM-DELIVERY-STATUS service	GatewayMSC-HLR	-
Short message service management services		MAP-READY-FOR-SM service	MSC-VLR,VLR-HLR,SGSN-HLR	N_OT
Short message service management services		MAP-ALERT-SERVICE-CENTRE service	HLR-InterworkingMSC	-
Short message service management services		MAP-INFORM-SERVICE-CENTRE service	HLR-GatewayMSC	-
Short message service management services		MAP-SEND-INFO-FOR-MT-SMS service	MSC-VLR	-
Short message service management services		MAP-SEND-INFO-FOR-MO-SMS service	MSC-VLR	-
Short message service management services		MAP-MT-FORWARD-SHORT-MESSAGE service	MSC-ServingMSC,GatewayMSC	-
Network-Requested PDP Context Activation		MAP_SEND_ROUTING_INFO_FOR_GPRS service	HLR-GGSN	-
Network-Requested PDP Context Activation		MAP_FAILURE_REPORT service	GGSN-HLR	-
Network-Requested PDP Context Activation		MAP_NOTE_MS_PRESENT_FOR_GPRS service	HLR-GGSN	-