3GPP TSG_CN#6 **NP-99399**
Meeting #6, Nice, France
13th - 15th December 1999

Source: **TSG_N1**

Title: **Liaison Statement on LCS CRs and GTSs for GSM Release 98 in SMG#30**

Agenda item: **4.1**

Document for: **Information**

3GPP TSG-CN-WG1, Meeting #8 ***Tdoc N1-99C92***
25-29 October 1999
Kobe, Japan

From : **3GPP TSG CN WG1 (SMG3 WPA)**
To : **T1P1.5**
CC: **3GPP TSG CN, CN WG2**
Title : **Liaison Statement on LCS CRs and GTSs for GSM Release 98 in SMG#30**

As requested in the liaison statement from T1P1.5 (N1-99C12), CN WG1 has reviewed the following LCS CRs and TSs intended for approval in SMG#30:

CR to GSM 03.71
CR to GSM 04.71
CR to GSM 09.08
GSM TS 09.31

CN WG1 has endorsed the CR to GSM 03.71, CR to GSM 04.71 and GSM TS 09.31. CN WG1 has approved the CR to GSM 09.08.

T1P1.5/99-464r3

3GPP TSG-CN-WG1, Meeting #8
25-29 October 1999
Kobe, Japan

Tdoc N1-99C13

CHANGE REQUEST

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

03.71	**CR**	**A001**	Current Version: 7.0.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑ *↑ CR number as allocated by MCC support team*

For submission to:	TSGN1	for approval	X	strategic		(for SMG
list expected approval meeting # here ↑		for information		non-strategic		use only)

Form: CR cover sheet, version 2 for 3GPP and SMG The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

Proposed change affects: *(at least one should be marked with an X)*	(U)SIM	X	ME	X	UTRAN / Radio		Core Network	X

Source:	T1P1.5	**Date:**	25.10.99
Subject:	Addition of further LCS functionality in GSM Release 98		
Work item:	Location Services (LCS)		

Category:	F	Correction		**Release:**	Phase 2	
	A	Corresponds to a correction in an earlier release			Release 96	
(only one category	B	Addition of feature			Release 97	
Shall be marked	C	Functional modification of feature	X		Release 98	X
With an X)	D	Editorial modification			Release 99	
					Release 00	

Reason for change:	Add revised LCS architecture and support for E-OTD and GPS positioning methods.
Clauses affected:	

Other specs Affected:	Other 3G core specifications		→ List of CRs:	
	Other GSM core specifications	X	→ List of CRs:	
	MS test specifications		→ List of CRs:	
	BSS test specifications		→ List of CRs:	
	O&M specifications		→ List of CRs:	

Other comments:	Blue highlighting shows additional changes in 11-15 October meeting of T1P1.5 LCS

TS V7.0.0 ()

Technical Specification

Digital cellular telecommunications system (Phase 2+); Location Services (LCS); (Functional description) - Stage 2 (GSM 03.71 version 7.0.0)

GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

European Telecommunications Standards Institute

Reference

RTS/SMG-030378QR1 (9o002ic3.PDF)

Keywords

Digital cellular telecommunications system, Global System for Mobile communications (GSM)

ETSI Secretariat

Postal address

F-06921 Sophia Antipolis Cedex - FRANCE

Office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

X.400

c= fr; a=atlas; p=etsi; s=secretariat

Internet

secretariat@etsi.fr
http://www.etsi.fr

Contents

1. Scope

This specification defines the stage-2 service description for the LoCation Services (LCS) feature on GSM, which provides the mechanisms to support mobile location services of operators, which are not covered by standardized GSM services. CCITT I.130 [7] describes a three-stage method for characterization of telecommunication services, and CCITT Q.65 [16]defines stage 2 of the method.

The LCS feature is a network feature and not a supplementary service. This version of the stage 2 service description covers aspects of LCS e.g., the functional model, architecture, positioning methods, message flows etc.

2. Normative references

This specification incorporates by dated and undated references, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this specification only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] GSM 01.04 (ETR 350): "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 02.71: "Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Service description; Stage 1".

[3] GSM 03.07 (ETR xxx): “Restoration Procedures”

[4] GSM 03.41: "Digital cellular telecommunication system (Phase 2+); Technical realization of Short Message Service Cell Broadcast (SMSCB)".

[5] GSM 03.49: "Digital cellular telecommunication system (Phase 2+); Example protocol stacks for interconnecting Cell Broadcast Centre (CBC) and Mobile-services Switching Centre (MSC)".

[6] GSM 03.78: “Digital cellular telecommunications system (Phase 2+); Customized Application for Mobile network Enhanced Logic (CAMEL) Phase 3; Stage 3”.

~~[5]~~[7] GSM 04.08: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification".

~~[6]~~[8] GSM 04.31: “Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Mobile Station (MS) – Serving Mobile Location Center (SMLC); Radio Resource LCS Protocol (RRLP).”

~~[7]~~[9] GSM 04.71: “Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 Location Services (LCS) specification”.

~~[9]~~[10] GSM 08.08: ” Digital cellular telecommunications system (Phase 2+); Mobile-services Switching Centre – Base Station System (MSC-BSS) interface; Layer 3 specification”.

~~[10]~~[11] GSM 08.31: “Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Serving Mobile Location Center (SMLC) – Serving Mobile Location Center (SMLC); SMLC Peer Protocol (SMLCPP).”

~~[11]~~[12] GSM 08.71: “Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Serving Mobile Location Center – Base Station Subsystem (SMLC-BSS) interface Layer 3 specification.”

~~[12]~~[13] GSM 09.02: "Digital cellular telecommunications system (Phase 2+); Mobile Application Part (MAP) specification".

[14] GSM 09.31: "Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Base Station System Application Part LCS Extension (BSSAP-LE)”.

~~[4]~~[15] CCITT Recommendations I.130: "General modelling methods – Method for the characterisation of telecommunication services supported by an ISDN and network capabilities of an ISDN".

~~[5]~~[16] CCITT Recommendation Q.65: "Methodology – Stage 2 of the method for the characterization of services supported by an ISDN".

3. Definitions, abbreviations and symbols

3.1 Definitions

For the purposes of this GTS the following definitions apply:

Location Estimate: the geographic location of an MS and/or a valid ME, expressed in latitude and longitude data. . The Location Estimate shall be represented in a well-defined universal format. Translation from this universal format to another geographic location system may be supported, although the details are considered outside the scope of the primitive services.

Mobile Assisted positioning: any mobile centric positioning method (e.g. E-OTD, GPS) in which the MS provides position measurements to the network for computation of a location estimate by the network. The network may provide assistance data to the MS to enable position measurements and/or improve measurement performance.

Mobile Based positioning: any mobile centric positioning method (e.g. E-OTD, GPS) in which the MS performs both position measurements and computation of a location estimate and where assistance data useful or essential to one or both of these functions is provided to the MS by the network. Position methods where an MS performs measurements and location computation without network assistance data (e.g. conventional GPS) are not considered within this category.

Mobile Originating Location Request (MO-LR): any location request from a client MS to the LCS Server made over the GSM air interface. While an MO-LR could be used to request the location of another MS, its primary purpose is to obtain an estimate of the client MS's own location either for the client MS itself or for another LCS client designated by the MS.

Mobile Terminating Location Request (MT-LR): any location request from an LCS client where the client is treated as being external to the PLMN to which the location request is made.

Network Induced Location Request (NI-LR): any location request for a target MS from a client that can be considered to lie inside any of the PLMN entities currently serving the target MS. In this case, the LCS client is also within the LCS server. Examples of an NI-LR include a location request needed for supplementary services, for emergency call origination and by O&M in a visited PLMN.

North American Emergency Services Routing Digits (NA-ESRD): a telephone number in the North American Numbering Plan (NANP) that can be used to identify a North American emergency services provider and any associated LCS client. The ESRD shall also identify the base station , cell site or sector from which a North American emergency call originates.

North American Emergency Services Routing Key (NA-ESRK): a telephone number in the North American Numbering Plan (NANP) assigned to an emergency services call by a North American VPLMN for the duration of the call that can be used to identify (e.g. route to) both the emergency services provider and the switch in the VPLMN currently serving the emergency caller. During the lifetime of an emergency services call, the ESRK can also be used to identify the calling mobile subscriber.

1.2.3.2 Abbreviations

Certain Aabbreviations used in this specification are also listed in GSM 01.04.0p.qq and TS xx.yy.
For the purposes of this specification, the following abbreviations apply:

ANM	Answer Message (ISUP)
BSSAP-LE	BSSAP LCS Extension for Lb, Lp and Ls interfaces
BSSLAP	BSS LCS Assistance Protocol
CC	SCCP Connection Confirm
CR	SCCP Connection Request
CREF	SCCP Connection Refused
DT1	SCCP Data Form 1 message
FEC	Forward Error Correction
IAM	Initial Address Message (ISUP)
LLLP	LMU LCS Protocol
LCF	Location Client Function
LCCF	Location Client Control Function
LCAF	Location Client Authorization Function
LDR	Location Deferred Request
LIR	Location Immediate Request
LLP	LMU LCS Protocol
LMMF	LMU Mobility Management Function
LMU	Location Measurement Unit
LSCF	Location System Control Function
LSAF	Location Subscriber Authorization Function
LSPF	Location Subscriber Privacy Function

LSBF	Location System Billing Function
LSBcF	Location System Broadcast Function
LSOF	Location System Operations Function
LCCTF	Location Client Coordinate Transformation Function
MO-LR	Mobile Originating Location Request
MT-LR	Mobile Terminating Location Request
NI-LR	Network Induced Location Request
MLC	Mobile Location Center
-PRAF	Positioning Radio Assistance Function
PRCF	Positioning Radio Coordination Function
PCF	Positioning Calculation Function
PSMF	Positioning Signal Measurement Function
RA	Rate Adaptation
REL	Release (ISUP)
RLC	Release Complete (ISUP or SCCP)
RLP	Radio Link Protocol (GSM 04.22)
RLSD	SCCP Released message
RRLP	RR LCS Protocol to a target MS (defined in GSM 04.xx)
S	
SLPP	Subscriber LCS Privacy Profile
SMLCPP	SMLC Peer Protocol (messages on Lp interface in GSM 09.yy)
TA	Timing Advance (between an MS and its serving BTS)
TOA	Time of Arrival
UDT	SCCP Unitdata message

1.3.3.3 Symbols

For the purposes of this specification, the following symbols apply:

Lb	Interface between Serving MLC and BSC (BSC interface)
Lc	Interface between gateway MLC and gsmSCF (CAMEL interface)
Le	Interface between External User and MLC (external interface)
Lh	Interface between Gateway MLC and HLR (HLR interface)
Lg	Interface between Gateway MLC and VMSC (gateway MLC interface)
Lp	Interface between SMLC and peer SMLC (peer interface)
Ls	Interface between Serving MLC and VMSC (serving MLC interface)
Lv	Interface between Serving MLC and VLR (VLR interface)
Um	Air Interface to an LMU (measurement interface)

4. Main concepts

LCS utilizes one or more positioning mechanisms in order to determine the location of a Mobile Station. Positioning a target MS involves two main steps: signal measurements and location estimate computation based on the measured signals.

Three positioning mechanisms are proposed for LCS: Uplink Time of Arrival (TOA), Enhanced Observed Time Difference (E-OTD), and Global Positioning System (GPS) assisted. TOA is described in this document. E-OTD and assisted GPS will be described in LCS phase 2.
Note: Due to regional regulatory mandates, TOA will be standardized for LCS first. Further work on E-OTD and GPS will continue after TOA is completed. At that time, descriptions of E-OTD and GPS will be moved into the main document.

4.1 Assumptions

- Support an SMLC that can be either BSS based or NSS based. While the SMLC is considered to be a separate logical entity, it may still be physically part of an MSC or BSC.
- Standardize a similarthe same open interface to the SMLC whether it is NSS or BSS based. This simplifies migration from an NSS to a BSS based location architecture and avoids two different types of SMLC.

- Support "Type A" LMUs accessed over the GSM air interface using the same signaling protocols for both BSS and NSS based SMLC interaction. A type A LMU supports the RR and MM signaling procedures defined in GSM 04.08. A type A LMU may have a subscription profile in the HLR and may support certain CM services – e.g. outgoing data calls for SW download and SMS for SIM card download.
- Support "Type B" LMUs accessed over the Abis interface. The LMU may be either free standing (support Abis signaling) or associated with a BTS – either integrated or connected by proprietary means. If free standing, a type B LMU could be identified using a pseudo cell ID.
- Employ the same application protocol defined in GSM 04.71 for all types of LMU.
- Use MTP, SCCP, BSSAP as the basis for all LCS signaling between the SMLC, BSC, MSC and (for GPRS) SGSN, since these are the only protocols that are all supported in a BSC, MSC and SGSN. Substitution of TCP/IP or FR could be used in 3G. An important consequence of this change is that TCAP and MAP are no longer needed for signaling to an SMLC (since retention of TCAP and MAP would only be feasible for an NSS based SMLC, thereby producing two distinct types of SMLC).
- Provide enough flexibility to enable usage of transport protocols other than MTP/SCCP to support LCS for GPRS and 3G.
- Employ SCCP connection oriented signaling in the NSS and BSS to access a type A LMU or target MS to enable LCS messages to be easily relayed through an MSC and BSC.
- Add signaling between peer SMLCs to enable an SMLC to request or receive E-OTD, TOA or GPS positioning and assistance measurements obtained by an LMU belonging to another SMLC.
- Enable migration from an NSS based SMLC to BSS based SMLCs.

4.2

4.1. Timing Advance (TA)

The TA is based on the existing Timing Advance (TA) parameter. The TA value is known for the serving BTS. To obtain TA values in case the MS is in idle mode a special call, not noticed by the GSM subscriber (no ringing tone), is set up. The cell-ID of the serving cell and the TA is returned as the result of the TA.
TA is used to assist all positioning mechanisms and as a fall-back procedure.

4.2. 4.3 Time of Arrival (TOA) positioning mechanism

The TOA positioning mechanism is based on collecting time of arrival (TOA) measurements computed from access bursts generated by the mobile. These bursts are generated by having the mobile perform an asynchronous intracell handover. Access bursts are received and measured by serving and neighboring base stations.
This method requires additional hardware at the listening BTSs to accurately measure the TOA of the bursts.

The uplink TOA positioning method is based on measuring the Time of Arrival (TOA) of a known signal sent from the mobile and received at three or more measurement units. The known signal is the access bursts generated by having the mobile perform an asynchronous handover. The method requires additional measurement unit (LMU) hardware in the network at the geographical vicinity of the mobile to be positioned to accurately measure the TOA of the bursts. Since the geographical coordinates of the measurement units are known, the mobile position can be calculated via hyperbolic triangulation. This method will work with existing mobiles without any modification

4.4 Enhanced Observed Time Difference (E-OTD) positioning mechanism

The E-OTD method is based on measurements in the MS of the Enhanced Observed Time Difference of arrival of bursts of nearby pairs of BTSs. For E-OTD measurement synchronization, normal and dummy bursts are used. When the transmission frames of BTSs are not synchronized, the network needs to measure the Relative or Absolute Time Differences (RTDs or ATDs) between them. To obtain accurate triangulation, E-OTD measurements and, for non-synchronized BTSs, RTD or ATD measurements are needed for at least three distinct pairs of geographically dispersed BTSs. Based on the measured E-OTD values the location of MS can be calculated either in the network or in the MS itself, if all the needed information is available in MS. See Annex C B for a detailed description of E-OTD.

4.5 -Global Positioning System (GPS) positioning mechanism

The Global Positioning System (GPS) method refers to any of several variants that make use of GPS signals or additional signals derived from GPS signals in order to calculate MS position. These variants give rise to a range of optional information flows between the MS and the network. One dimension of variation is where position calculation is performed: a) MS-based PCF or b) network-based PCF. Another dimension is whether “assistance data” is required - irrespective of where position calculation is performed. Examples of assistance data include differential GPS data; lists of satellites in view based on approximate MS position, etc. A third dimension of variation is closely related to the preceding, namely, the origin and distribution of any assistance data. For example, even while assistance data may be required of a GPS method, it may be optional that the assistance data originates from and is distributed within and by the PLMN, VPLMN, etc.

5. General LCS architecture

5.1.5.1 LCS access interfaces and reference points

There is one reference point between the LCS PLMN server and LCS client called Le. Le is described in GSM 02.71 however the protocol specifics are for further study. There may be more than a single LCS network interface to several different LCS clients or other networks. These networks may both differ in ownership as well as in communications protocol. The network operator should define and negotiate interconnect with each external LCS client or other network.

An interface differs from a reference point in that an interface is defined where specific LCS information is exchanges and needs to be fully recognized.

There is an inter-LCS PLMN interface called Lg that connects two independent LCS networks for message exchange.

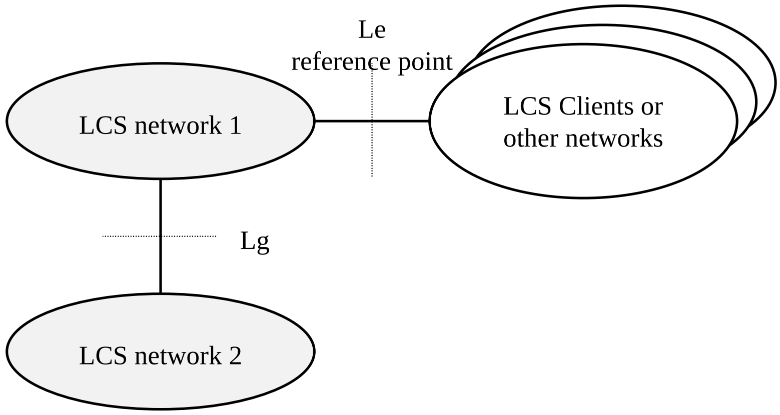


Figure 11 LCS Access Interfaces and Reference Points

5.2.5.2 LCS Functional diagram

GSM 02.71 [2] describes the overall LCS service description from the LCS client point of view. In this specification, a more detailed description of LCS is given. The LCS functional diagram shown in Figure 3 depicts the interaction of the LCS client and the LCS server within the PLMN. The PLMN uses the various LCS components within LCS server to provide the target MS Location Information to the LCS client.

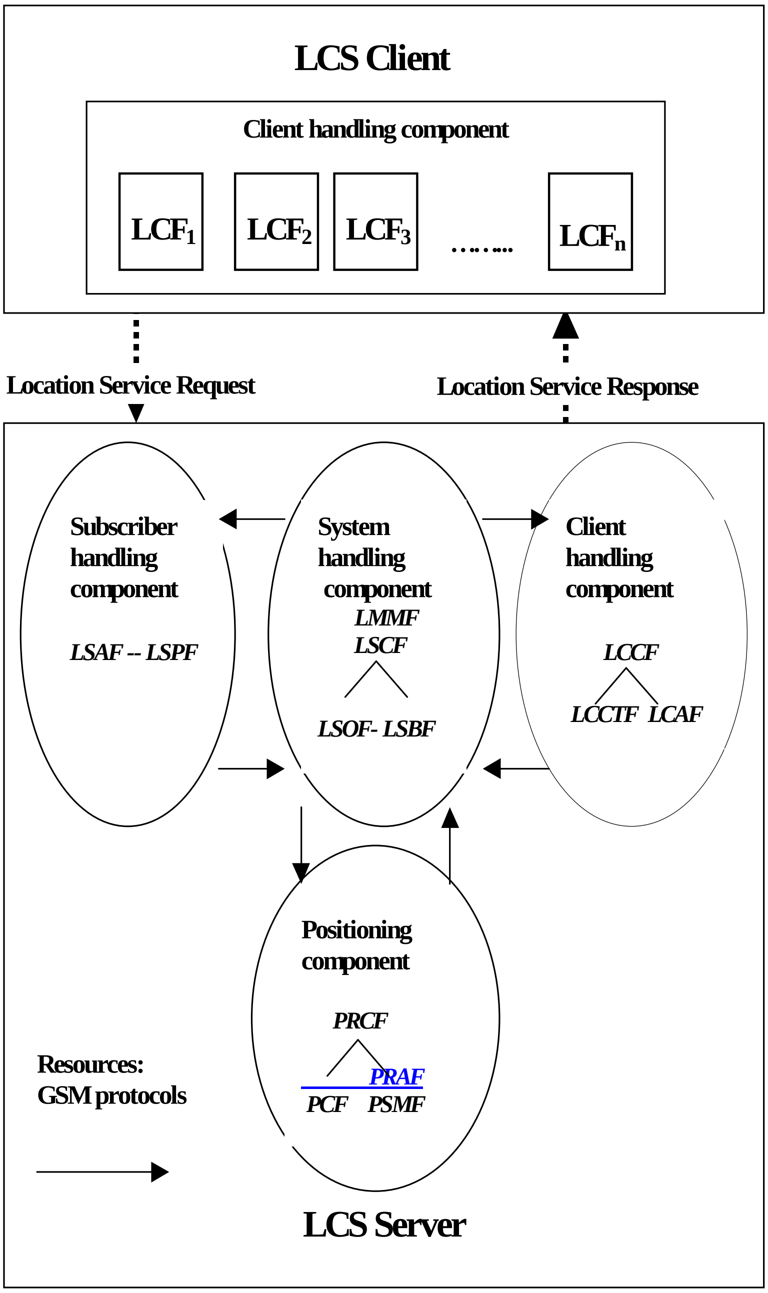


Figure 3~~2~~ PLMN LCS capability server Functional Diagram

~~5.3.~~5.3 LCS CLIENT

An LCS client contains an LCS component with one or more client(s) which by using location information can provide location based services.

An LCS client is a logical functional entity that requests from the LCS server in the PLMN location information for one or more than one target MS within a specified set of parameters such as Quality of Service (QoS). The LCS Client may reside in an entity (including the MS) within the PLMN or in an entity external to the PLMN. The specification of the LCS Client's internal logic and its relation to the external use is outside the scope of this document.

~~1.1.1.~~5.3.1 LCS Component

5.3.1.1 Location Client Function (LCF)

The Location Client Function (LCF) provides a logical interface between the LCS client and the LCS server. . This function is responsible for requesting location information for one or more MEs/MSs with a specified “QoS” and receiving a response, which contains either location information or a failure indicator.

~~5.4.~~5.4 LCS Server

~~5.4.1.~~5.4.1 Client handling component

~~5.4.1.1~~5.4.1.1 Location Client Control Function (LCCF)

The Location Client Control Function (LCCF) manages the external interface towards LCF. . The LCCF identifies the LCS client within the GSM PLMN by requesting client verification and authorization (i.e. verifies that the LCS client is allowed to position the subscriber) through interaction with the Location Client Authorization Function (LCAF) . The LCCF handles mobility management for location services (LCS) e.g., forwarding of positioning requests to VMSC. The LCCF determines if the final positioning estimate satisfies the QoS for the purpose of retry/reject. The LCCF provides flow control of positioning requests between simultaneous positioning requests. It may order the Location Client Coordinate Transformation Function (LCCTF) to perform a transformation to local coordinates. It also generates charging and billing related data for LCS via the Location System Billing Function (LSBF).

~~1.1.1.2~~5.4.1.2 Location Client Authorization Function (LCAF)

The Location Client Authorization Function (LCAF) is responsible for providing access and subscription authorization to a client. Specifically, it provides authorization to a LCS client requesting access to the network and authorizes the subscription of a client. LCAF provides authorization to a LCS client requesting Location Information of a specific MS.

~~1.1.1.1.1~~5.4.1.2.1 Access Subfunction

An *Access Subfunction* enables LCS clients to access LCS services. This subfunction provides verification and authorization of the requesting client.
When a LCS is requested, the Access Subfunction uses the information stored in the LCS client *subscription profile* to verify that:

- the LCS client is registered; and
- the LCS client is authorized to use the specified LCS request type;
- the LCS client is allowed to request location information for the subscriber(s) specified in the LCS request;

5.4.1.2.2 Subscription Subfunction

The LCS client Subscription profile shall contain a minimum set of parameters assigned on per LCS client basis for an agreed contractual period. The LCS client profile shall contain the following set of access parameters:

- LCS client identity;
- Allowed LCS request types (i.e. LIR, LDR or both);
- Maximum number of subscribers allowed in a single LCS request;
- Priority;
- Position override indicator;
- State(s) ;
- Event(s) (applicable to LDR requests only);
- Local coordinate system;
- LCS client access barring list (optional);
- PLMN access barring list applicability ;

For certain authorized LCS client internal to the PLMN, a subscription profile is unnecessary. These clients are empowered to access any defined service that is not barred for an MS subscriber. This permits positioning of emergency calls without the need for pre-subscription.

~~1.1.2.~~5.4.2 System handling component

5.4.2.1 LMU Mobility Management Function (LMMF)

The LMU Mobility Management Function (LMMF) is responsible for maintaining the operational status of LMUs and registering each LMU in an SMLC. Operation of the LMMF is independent of other logical LCS functions and its output is provided to the PRCF. The LMMF only applies to Type A LMUs.

~~1.1.1.2~~5.4.2.2 Location System Control Function (LSCF)

The Location System Control Function (LSCF) is responsible for coordinating location requests. This function manages call-related and non-call-related positioning requests of GSM LCS and allocates network resources for handling them. The LSCF retrieves MS classmark for the purpose of determining a positioning method. The LSCF performs call setup if required as part of a LCS e.g., putting the ME in a dedicated mode and obtains Cell-ID. It also caters for coordinating resources and activities with regard to requests related to providing assistance data needed for positioning. This function interfaces with the LCCF, LSPF, LSBF and PRCF. Using these interfaces, it conveys positioning requests to the PRCF, relays positioning data to the LCCF and passes charging related data to the LSBF.

~~1.1.1.3~~5.4.2.3 Location System Billing Function (LSBF)

The Location System Billing Function (LSBF) is responsible for charging and billing activity within the network related to location services (LCS). This includes charging and billing of both clients and subscribers. Specifically, it collects charging related data and data for accounting between PLMNs.

~~1.1.1.4~~5.4.2.4 Location Client Coordinate Transformation Function (LCCTF)

The Location Client Coordinate Transformation Function (LCCTF) provides conversion of a location estimate expressed according to a universal latitude and longitude system into an estimate expressed according to a local geographic system understood by the LCF and known as location information. The local system required for a particular LCF will be either known from subscription information or explicitly indicated by the LCF.

~~1.1.1.5~~5.4.2.5 Location System Operations Function (LSOF)

The Location System Operations Function (LSOF) is responsible for provisioning of data, positioning capabilities, data related to clients and subscription (LCS client data and MS data), validation, fault management and performance management of GSM LCS.

5.4.2.6 Location System Broadcast Function (LSBcF)

The Location System Broadcast Function (LSBcF) provides broadcast capability. The LSBcF capability is only used when broadcast data is required for E-OTD or A-GPS positioning methods.

~~1.1.3.~~5.4.3 Subscriber Component

5.4.3.1 Location Subscriber Authorization Function (LSAF)

The Location Subscriber Authorization Function (LSAF) is responsible for authorizing the provision of a location service (LCS) for a particular mobile. Specifically, this function validates that a GSM LCS can be applied to a given subscriber. The LSAF verifies the client MS’s subscription.

~~1.1.1.2~~5.4.3.2 Location Subscriber Privacy Function (LSPF)

The Location Subscriber Privacy function is responsible performs all privacy related authorizations. For an target MS it shall authorize the positioning request versus the privacy options of the target MS, if any.

1.1.4.5.4.4 Positioning component

5.4.4.1 Positioning Radio Coordination Function (PRCF)

The Positioning Radio Control Function (PRCF) manages the positioning of a mobile through overall coordination and scheduling of resources to perform positioning measurements. This function interfaces with the PSMF and PCF and possibly with a PRAF. The PRCF determines the positioning method to be used based on the QoS, the capabiities of the network, and the MS's location capabilities. It determines which PSMFs to be involved or what to measure, and obtains processed signal measurements from PSMF. Next, it packs the signal measurement data from the PSMF into a certain format and forwards it to the PCF.

5.4.4.2 Positioning Radio Assistance Function (PRAF)

The Positioning Radio Assistance Function (PRAF) provides additional support for the PRCF when radio coordination is distributed among multiple network elements. A particular function of the PRAF for network based position methods is to induce positioning signals from the target MS. For mobile based and mobile assisted position methods, the PRAF could induce position signals from the network or from some other external reference source.

1.1.1.25.4.4.3 Positioning Calculation Function (PCF)

The Positioning Calculation Function (PCF) is responsible for calculating the position of the mobile. It obtains BTS related data e.g., BTS geographic co-ordinates and stores this data. This function applies an algorithmic computation on the collected signal measurements to compute the final location estimate and accuracy. It also supports conversion of mobile's location estimate between different geodatic reference systems.

1.1.1.35.4.4.4 Positioning Signal Measurement Function (PSMF)

The Positioning Signal Measurement Function (PSMF) is responsible for gathering uplink or downlink radio signal measurements for calculation of a mobile's position. These measurements can be positioning related or ancillary.

5.5.5.5 Information Flows between Client and Server

Other types of national specific information flows may be supported in addition to the information flow specified here.

Any of the information flows here indicated may not be externally realized if the information does not flow over an open interface. On the other hand, if a flow goes over an open interface, it shall abide to a well-defined protocol, which will be further specified in other relevant specifications.

1.1.1.5.5.1 Location Service Request

Via the Location Service Request, the LCS client communicates with the LCS server to request for the location information of one or more than one MS within a specified quality of service. There exist two types of location service requests:

- Location Immediate Request (LIR); and
- Location Deferred Request (LDR).

The following attributes are identified for Location Service Request information flow:
- Target MS ;
- LCS identity;
- State (idle, dedicated)
- Event (applicable to LDR requests only);
- Quality of Service information;
- Local coordinate system;
- Geographical area.

5.5.2.5.5.2 Location Service Response

The Location Service Response is sent to the LCS client as the result of the Location Service Request by the LCS Server:

- Immediate Response; and

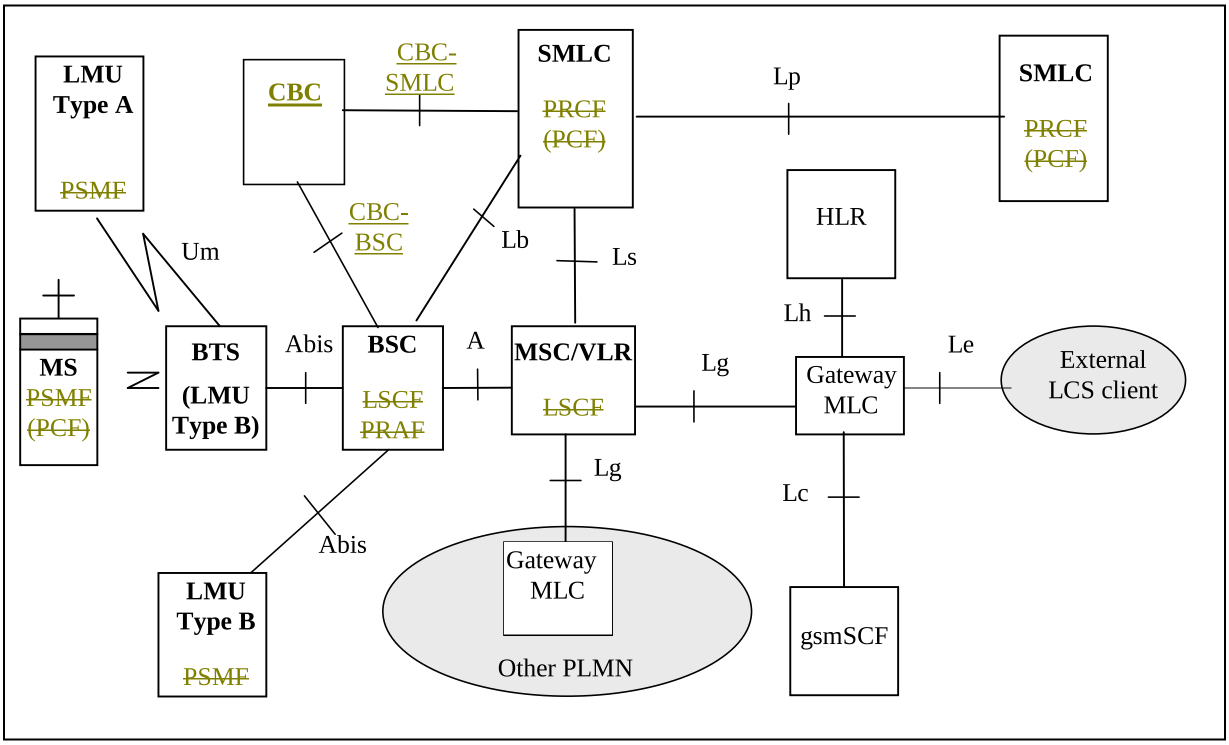
- Deferred Response;

These deferred responses can be either single or periodic.

~~5.6.~~5.6 Logical architecture

Editorial Note: the use of CBS to broadcast E-OTD and GPS assistance data to a target MS is still under consideration by T1P1.5 for Release 98. The architecture here assumes that CBS is used. For Release 98, no other alternative to CBS is being considered.

LCS is logically implemented on the GSM structure through the addition of one network node, the Mobile Location Center (MLC). It is necessary to name a number of new interfaces. A generic LCS logical architecture is shown below in Figure 5. LCS generic architecture can be combined to produce LCS architecture variants. No inference should be drawn about the physical configuration on an interface from Figure 5.



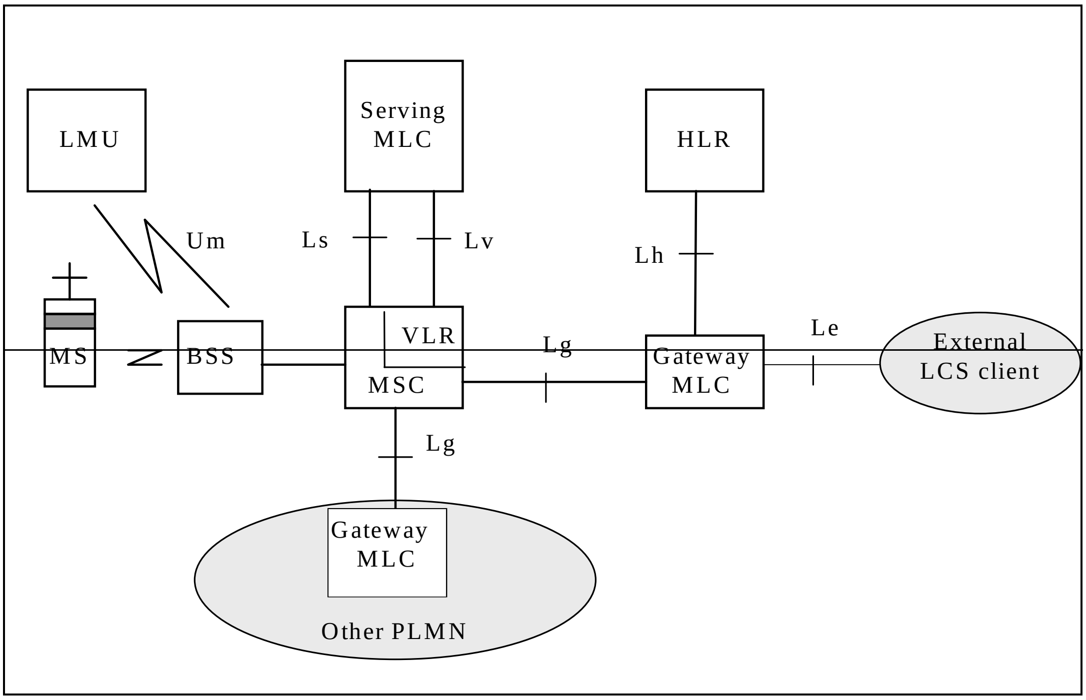


Figure 5~~4~~3 Generic LCS Logical Architecture

~~5.6.1.~~5.6.1 BSS

The BSS is involved in the handling of various positioning procedures~~. As a generic handling procedure, the BSS provides Cell-id and TA to the VMSC.~~ Specific BSS functionality is specified in each of the positioning procedures section.

~~5.6.2.~~5.6.2 LCS Client

The LCS client is outside the scope of this standard.

~~5.6.3.~~5.6.3 GMLC

The Gateway Mobile Location Center (GMLC) contains functionality required to support LCS. In one PLMN, there may be more than one GMLC.

The GMLC is the first node an external LCS client accesses in a GSM PLMN (i.e. the Le reference point is supported by the GMLC). The GMLC may request routing information from the HLR via the Lh interface. After performing registration authorization, it sends positioning requests to and receives final location estimates from the VMSC via the Lg interface.

~~5.6.4.~~5.6.4 SMLC

The Serving Mobile Location Center (SMLC) contains functionality required to support LCS. In one PLMN, there may be more than one SMLC.

~~The SMLC is the node that is serving the MS (i.e. the Ls interface is supported by the SMLC to the MSC).~~ The SMLC manages the overall coordination and scheduling of resources required to perform positioning of a mobile. It also calculates the final location estimate and accuracy.

Two types of SMLC are possible:

NSS based SMLC: supports the Ls ~~but not Lb~~ interface.
BSS based SMLC: supports the Lb ~~but not Ls~~ interface

An NSS based SMLC supports positioning of a target MS via signaling on the Ls interface to the visited MSC. A BSS based SMLC supports positioning via signaling on the Lb interface to the BSC serving the target MS. Both types of SMLC may support the Lp interface to enable access to information and resources owned by another SMLC.

The SMLC controls a number of LMUs for the purpose of obtaining radio interface measurements to locate or help locate MS subscribers in the area that it serves. The SMLC is administered with the capabilities and types of measurement produced by each of its LMUs. Signaling between an NSS based SMLC and LMU is transferred via the MSC serving the LMU using the Ls interface and either the Um interfaces for a Type A LMU or the Abis interface for a Type B LMU. Signaling between a BSS based SMLC and LMU is transferred via the BSC that serves or controls the LMU using the Lb interface and either the Um interface for a Type A LMU or the Abis interface for a Type B LMU. The following measurements returned by an LMU to an SMLC have a generic status in being usable for more than one position method (e.g. including TOA):

(a) Radio interface timing information

The SMLC and GMLC functionality may be combined in the same physical node, combined in existing physical nodes, or reside in different nodes. The SMLC and GMLC are not interconnected. They are connected through the VMSC. When the VMSC and GMLC are in different PLMNs, they are interconnected via the Lg interface.

Two types of SMLC are possible:

NSS based SMLC: supports the Ls but not Lb interface.

BSS based SMLC: supports the Lb but not Ls interface

For Location Services, when a Cell Broadcast Center (CBC) is associated with a BSC, the SMLC may interface to a CBC in order to broadcast assistance data using existing cell broadcast capabilities. The SMLC shall behave as a user, Cell Broadcast Entity, to the CBC [refer to GSM.03.41].

5.6.5.5.6.5 MS

The MS may be involved in the various positioning procedures. Specific MS involvement is specified in each of the positioning procedures section.

5.6.6.5.6.6 LMU

An LMU makes radio measurements to support one or more positioning methods. These measurements fall into one of two categories:

(a) Location measurements specific to one MS used to compute the location of this MS

(b) Assistance measurements specific to all MSs in a certain geographic area

All location and assistance measurements obtained by an LMU are supplied to a particular SMLC associated with the LMU. Instructions concerning the timing, the nature and any periodicity of these measurements are either provided by the SMLC or are pre-administered in the LMU.

Two types of LMU are defined

Type A LMU: accessed over the normal GSM air interface

Type B LMU: accessed over the Abis interface

A type A LMU is accessed exclusively over the GSM air interface (Um interface): there is no wired connection to any other network element. A type A LMU has a serving BTS and BSC that provide signaling access to a controlling SMLC. With an NSS based SMLC, a type A LMU also has a serving MSC and VLR and a subscription profile in an HLR. A type A LMU always has a unique IMSI and supports all radio resource and mobility management functions of the GSM air interface that are necessary to support signaling using an SDCCH to the SMLC. A type A LMU supports those connection management functions necessary to support LCS signaling transactions with the SMLC and may support certain call control functions of to support signaling to an SMLC using a circuit switched data connection.
All signaling to an LMU is exclusively over the GSM air interface (Um Interface): there is no wired connection to any other network element. An LMU thus has a serving BTS, BSC, MSC and VLR in addition to an SMLC and interacts with the first

four of these like a normal GSM MS. In particular, an LMU has its own IMSI and subscription profile in a home HLR and supports all radio resource and mobility management functions of the GSM air interface that are necessary components to the LMU procedures defined here.

Note: A network operator may assign specific ranges of IMSI for its LMUs and may assign certain digits within the IMSI to indicate the associated SMLC. Certain digits in the IMSI may also be used as a local identifier for an LMU within an SMLC.

To ensure that a Type Athe LMU and its associated SMLC can always access one another, an LMU may be homed (camped) on a particular cell site or group of cell siteslocation area (or location areas) belonging to one BSC or one MSC.. For anyreal Type A LMUs with a subscription profile in an HLR (applies only with an NSS based SMLC), the HLR contains a special profile is used indicating no supplementary services, except possibly SMS-PP MT (for data download via the SIM application toolkit), and barring of all incoming and possibly outgoing calls. An identifier in the HLR profile also distinguishes an LMU from a normal MS. All other data specific to an LMU is administered in the LMU and in its associated SMLC.

A Type B LMU is accessed over the Abis interface from a BSC. The LMU may be either a standalone network element addressed using some some pseudo-cell ID or connected to or integrated in a BTS. Signaling to a Type B LMU is by means of messages routed through the controlling BSC for a BSS based SMLC or messages routed through a controlling BSC and MSC for an NSS based SMLC.

The following assistance measurements obtained by an LMU have a generic status in being usable by more than one position method:

Radio Interface Timing measurements – comprise Absolute Time Differences (ATDs) or Real Time Differences (RTDs) of the signals transmitted by Base Stations, where timing differences are measured relative to either some absolute time reference difference (ATD) or the signals of another Base Station (RTD).

5.6.7.5.6.7 MSC

The MSC contains functionality responsible for MS subscription authorization and managing call-related and non-call related positioning requests of GSM LCS. The MSC is accessible to the GMLC via the Lg interface and the SMLC via the Ls interface.

5.6.8.VLR

The VLR is responsible for registering an LMU in its associated SMLC after the LMU has performed a successful location update. The VLR also deregisters any LMU that has been purged or cancelled in the VLR. Signaling to support registration and deregistration is transferred via the Lv interface between the VLR and SMLC.

5.6.9.5.6.8 HLR

The HLR contains LCS subscription data and routing information. The HLR is accessible from the GMLC via the Lh interface. For roaming MSs, HLR may be in a different PLMN that the current SMLC.

5.6.9 gsmSCF

The Lc interface supports CAMEL access to LCS and is applicable only in CAMEL phase 3. The procedures and signaling associated with it are defined in GSM 03.78 and GSM 09.02, respectively.

5.6.10 LMU and SMLC association

The LCS architecture is intended to support a high degree of flexibility, whereby any physical SMLC can support multiple Ls or Lb interfaces (e.g. allowing a BSS based SMLC to serve multiple BSCs) and whereby a mixture of different SMLC types can serve a single network or single MSC area. Figure 2 illustrates the case where different SMLC types and different LMU types are supported in a single MSC area.

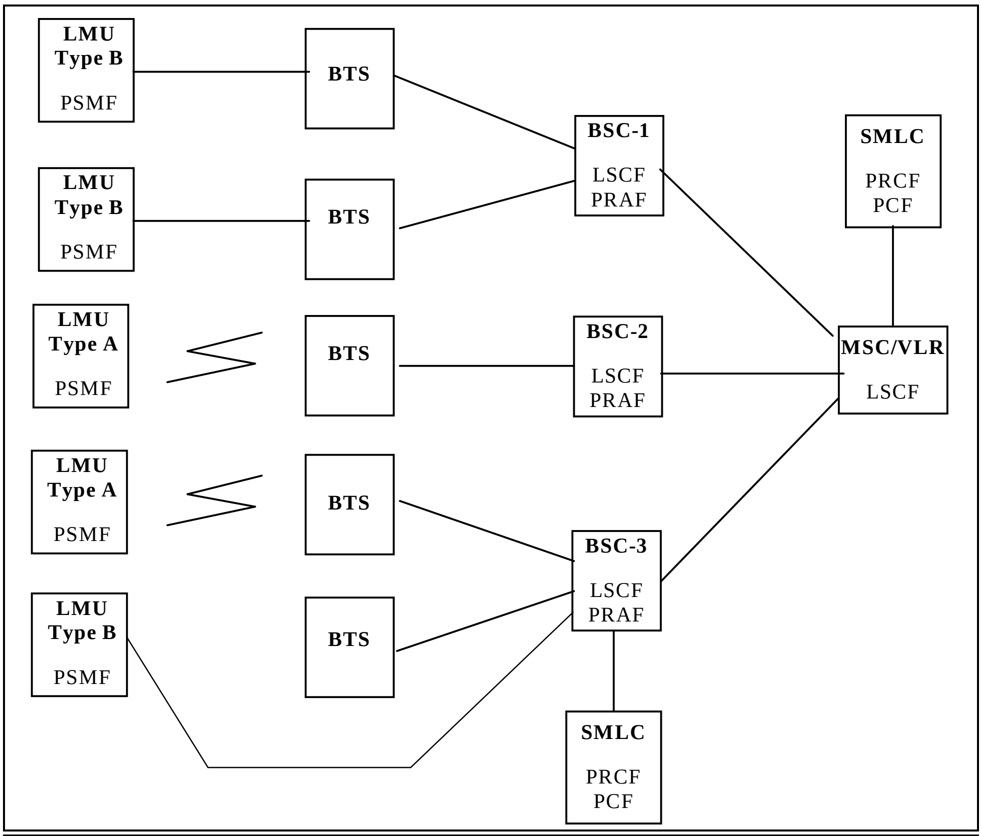


Figure 2 – Mixed Network with BSS and NSS based SMLCs and Type A and B LMUs

5.7 Embedded Architecture

The embedded common open architecture between the logical LCS functions is shown in Figure 3. This architecture applies to both BSS and NSS based SMLCs and to both types of LMU.

The protocol between peer SMLCs allows an LMU to effectively perform measurements for any one or more of several SMLCs and may be used to solve border area problems where LMUs on one side of an SMLC border would not normally be available to the SMLCs that control LMUs on the side. The intent is to impact only the SMLC in resolving border area problems and not LMUs.

~~**Editorial Comment:** there were proposals in the Cambridge meeting to explicitly indicate SMLC-SMLC signaling interaction in Figure 2 and add more (e.g. a figure) to describe how this could resolve SMLC border problems. This is still a potential addition for a later revision.~~

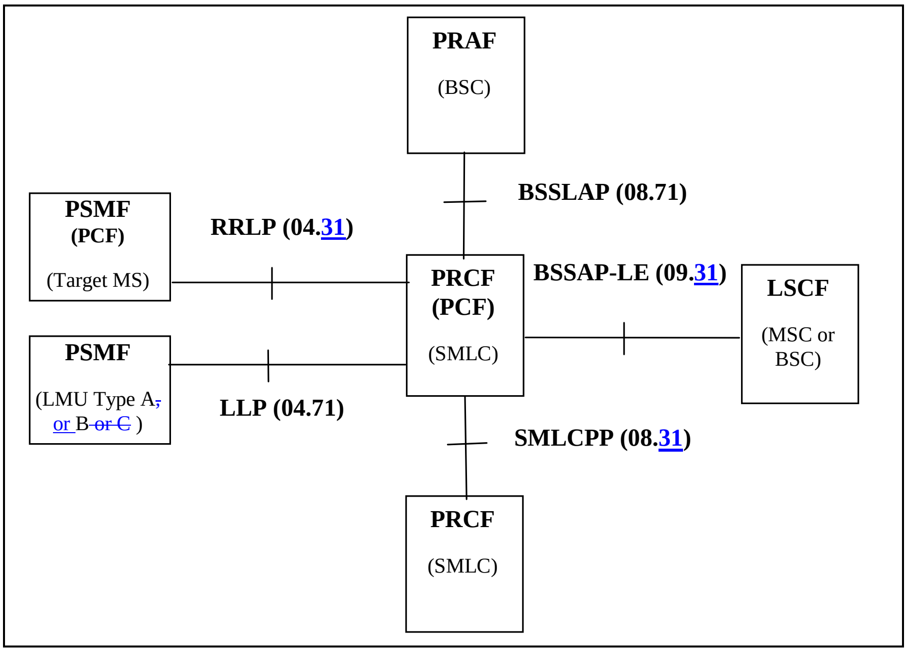


Figure 3 – Common Embedded Architecture between Logical LCS Functions

~~5.7.~~5.8 Assignment of functions to general logical architecture

~~Table 1Table 1 maps LCS functions into network elements.~~

	MS	LMU	BTS	BSC	GMLC	SMLC	MSC	HLR	gsmSCF	LCS -Client
LCF	X						X		X	X
LCCF					X					
LCAF					X					
LMMF						X				
LSCF							X			
LSPF								X		
LSAF							X			
LSBF					X		X			
LSBcF						X				
LSOF		X		X	X	X	X			
LCCTF					X					
PRAF				X						
PRCF						X				
PCF	X					X				
PSMF	X	X	X							

Table 1 Mapping of LCS Functions into Network Elements

6 Signaling Protocols and Interfaces

6.1 ~~Open Issue 10: the term BSSAP, as used here for the A interface, refers to existing BSSAP plus some or all messages in BSSAP-LE.~~

When the signaling is more stable, new terms may be useful to distinguish the exact subset of BSSAP-LE that is being added to a particular A interface. This would address comments in the Cambridge meeting concerning ambiguity in BSSAP references.

4.1 Generic Signaling Model for LCS

6.1.1 Protocol layering

Figure 4 shows the generic signaling model applicable to LCS for any signaling interaction in which an SMLC forms at least one of the signaling end points.

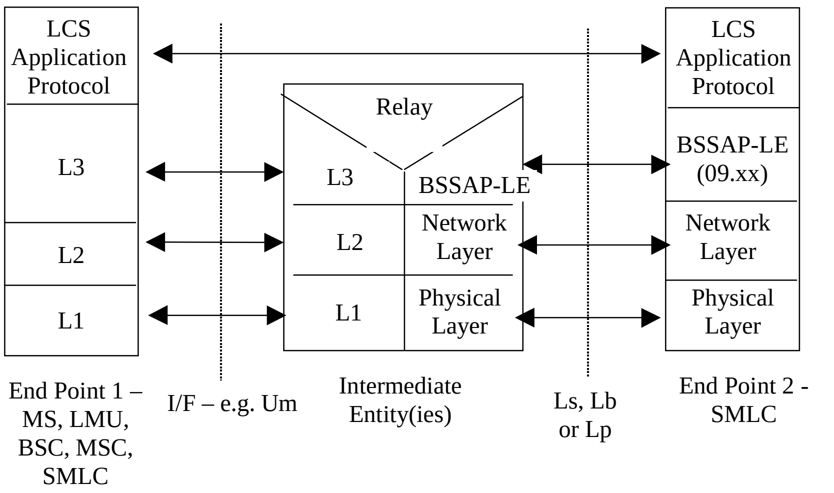


Figure 7 Figure 4 – Generic Model for LCS Signaling to an SMLC

The functions performed by each protocol layer are as follows.

(a) LCS application protocol – this depends on the other signaling end point (e.g. whether a target MS or LMU) and may be absent if supported in the BSSAP-LE layer. The application protocol supports specific LCS functions (e.g. positioning measurements, assistance measurements) and is independent of lower protocol layers.

(b) BSSAP-LE – this is an extension of BSSAP and carries the LCS application protocol signaling units. Necessary functions include identification of the LCS application protocol and identification, where not provided by the network layer, of the two end points. This layer can be relayed by an intermediate entity or mapped into an equivalent layer 3 protocol used by the other signaling end point.

(c) Network Layer – provides signaling transport between the SMLC and either the other end point or some intermediate entity at which the BSSAP-LE layer is relayed or mapped. The network layer may support connection oriented or connectionless signaling. For second generation circuit oriented applications, the network layer is provided using MTP and SCCP. For third generation and packet oriented applications, other protocols may be used.

(d) Physical Layer – for second generation circuit oriented applications, SS7 signaling links are supported by the physical layer.

(e) L3 – a protocol layer compatible with or the same as BSSAP-LE.

(f) L2 – logical link layer for the other endpoint

(g) L1 – physical layer for the other end point.

Editorial note: need to define RRLP protocol also

6.1.2.6.1.2 Message Segmentation

Message segmentation is needed to transport any large LCS message that exceeds the message size limitation supported by any GSM interface over which transport is needed.

6.1.2.1 Application Level Segmentation

Segmentation and reassembly of large RRLP, LLP and SMLCPP messages at the application level (i.e. in the endpoint sender or receiver application for RRLP, LLP or SMLCPP) shall be supported. The associated procedures are defined in GSM 04.31, 04.71 and 08.31. The sending application shall use a segment size that when expanded with additional lower level protocol headers does not exceed the maximum supported message size on any intervening interface between the sender and receiver. The sending, receiving and all intermediate entities supporting message transfer at the BSSAP-LE level shall ensure reliable and sequenced delivery of the message segments by appropriate use of the capabilities supported by lower transport and network level protocols (e.g. use of SCCP class 1 for connectionless transfer).

6.1.2.2 Network Level Segmentation

Segmentation and reassembly of large RRLP, LLP and SMLCPP messages at the network (e.g. SCCP) level may be supported. For message transfer over any interface where network level segmentation is not supported (e.g. Abis interface, Um interface), segmentation at the application level shall be used. This implies support of both network and application level segmentation by certain intermediate entities.

6.2 4.2 Signaling between an SMLC, MSC and BSC

Figures 5 and 6 show the protocol layers used to support LCS signaling between the SMLC, MSC and BSC with an NSS based and BSS based SMLC, respectively.

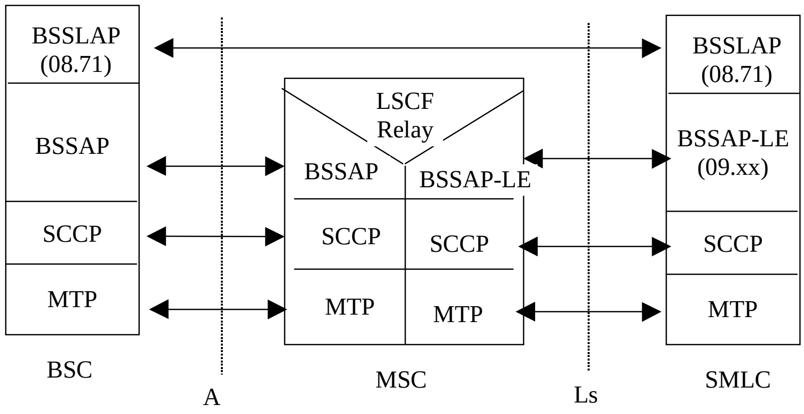


Figure 8~~Figure 5~~ – Signaling Protocols between SMLC, MSC and BSC with NSS based SMLC

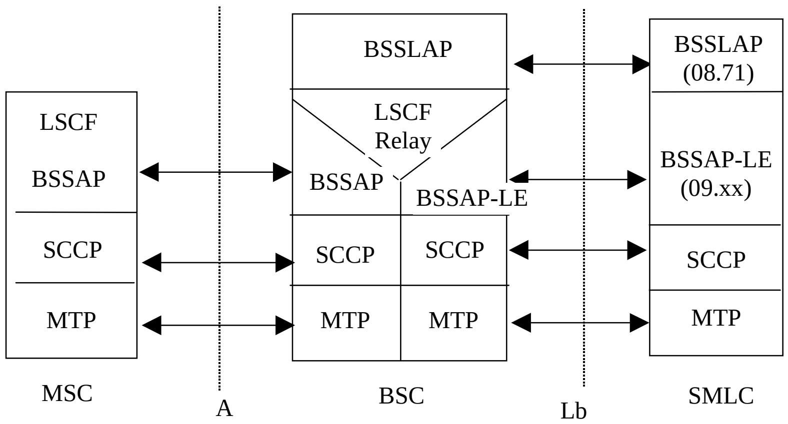


Figure 9 ~~Figure 6 –~~ Signaling Protocols between SMLC, MSC and BSC with BSS based SMLC

6.3 ~~4.3~~ SMLC Signaling to a Target MS

Figures 7 and 8 show the protocol layers used to support signaling between an SMLC and target MS with an NSS based and BSS based SMLC, respectively.

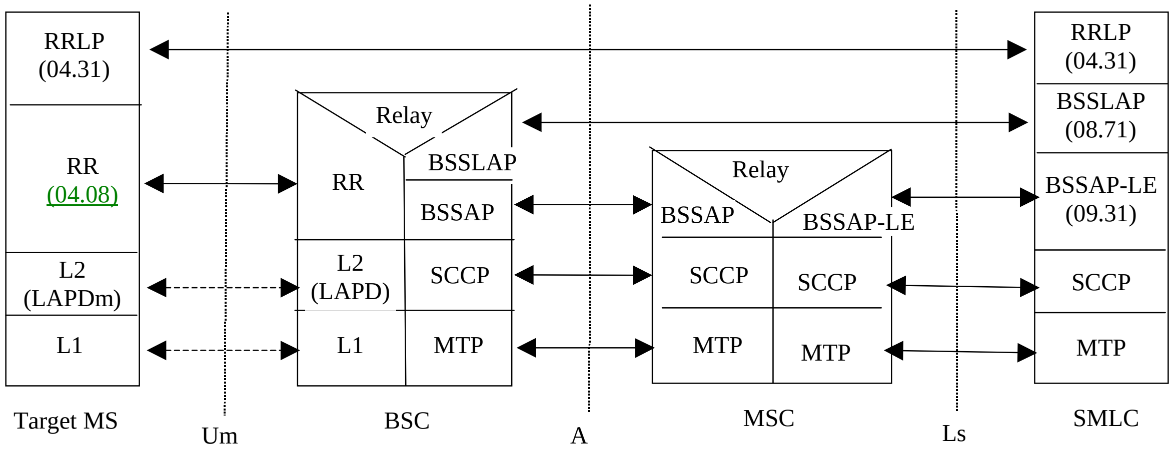


Figure 10– Signaling between an SMLC and Target MS with NSS based SMLC

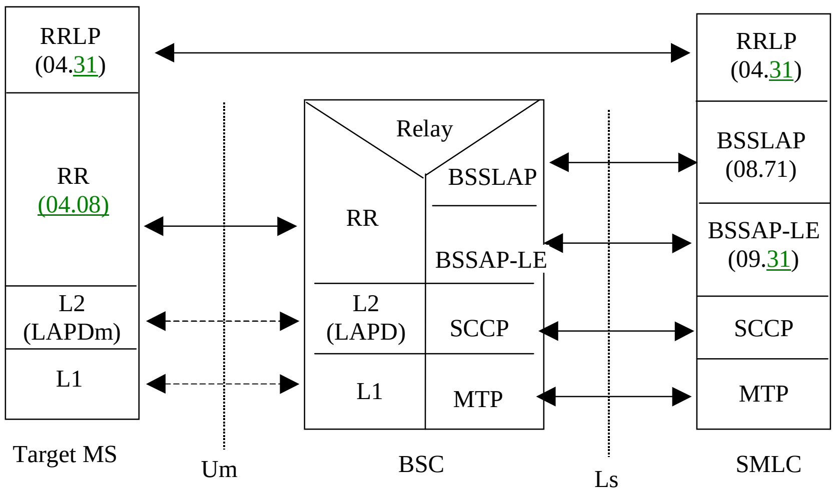


Figure 11– Signaling between an SMLC and Target MS with BSS based SMLC

4.4 6.4 -SMLC Signaling to a Type A LMU

6.4.1 4.4.1 Signaling using an SDCCH

Figures 9 and 10 show the protocol layers used to support signaling between an SMLC and a Type A LMU with an NSS and BSS based SMLC, respectively, using an SDCCH on the Um interface.

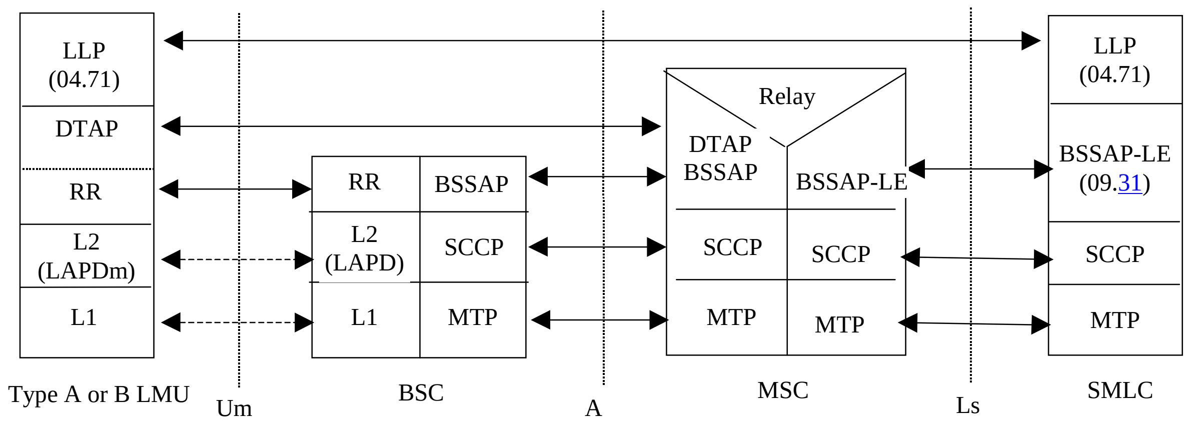


Figure 12~~Figure 9~~ – Signaling between an SMLC and a Type A LMU with NSS based SMLC using an SDCCH

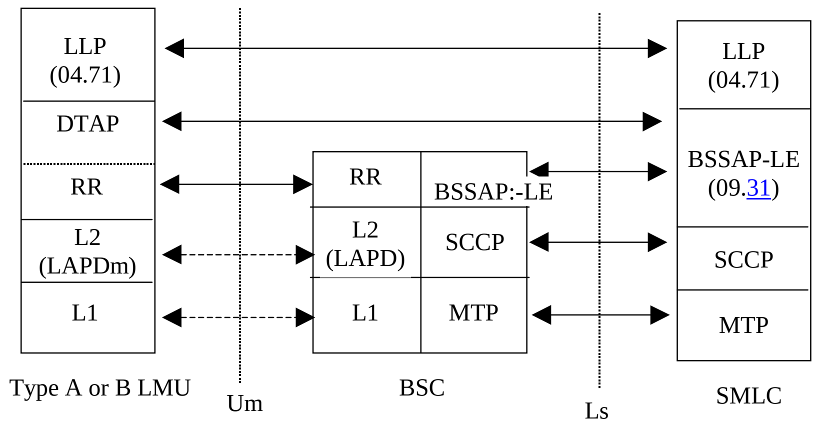


Figure 13~~Figure 10~~ – Signaling between an SMLC and Type A LMU with BSS based SMLC using an SDCCH

6.4.2 ~~4.4.2~~ Signaling using a TCH

Figures 11 to 13 show the protocol layers that can be used to support signaling between an SMLC and a Type A LMU with an NSS and BSS based SMLC using a TCH on the Um interface. The TCH is assumed to support either transparent or non-transparent synchronous data and may be provided in a multislot configuration. The main usage would be for O&M data and SW download – e.g. during offpeak hours.

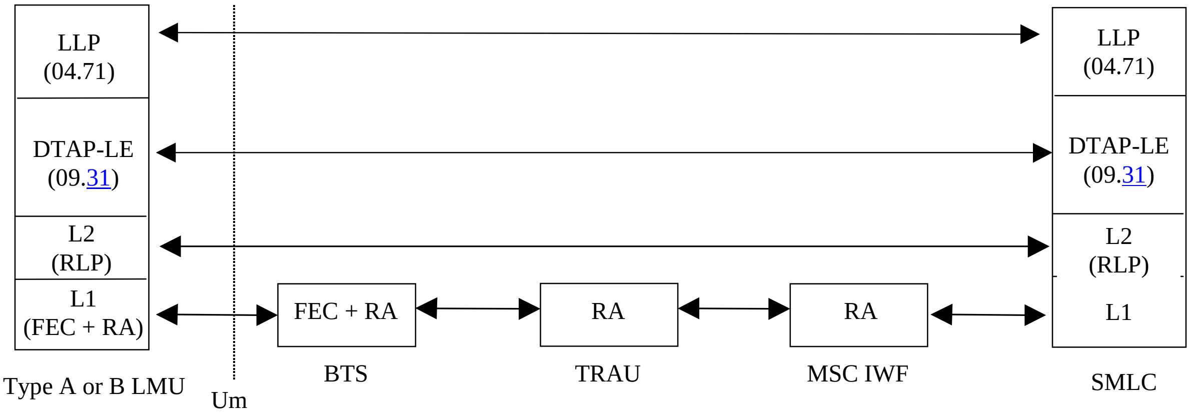


Figure 14~~Figure 11 –~~ Signaling between an SMLC and a Type A LMU with NSS based SMLC using a TCH in transparent mode

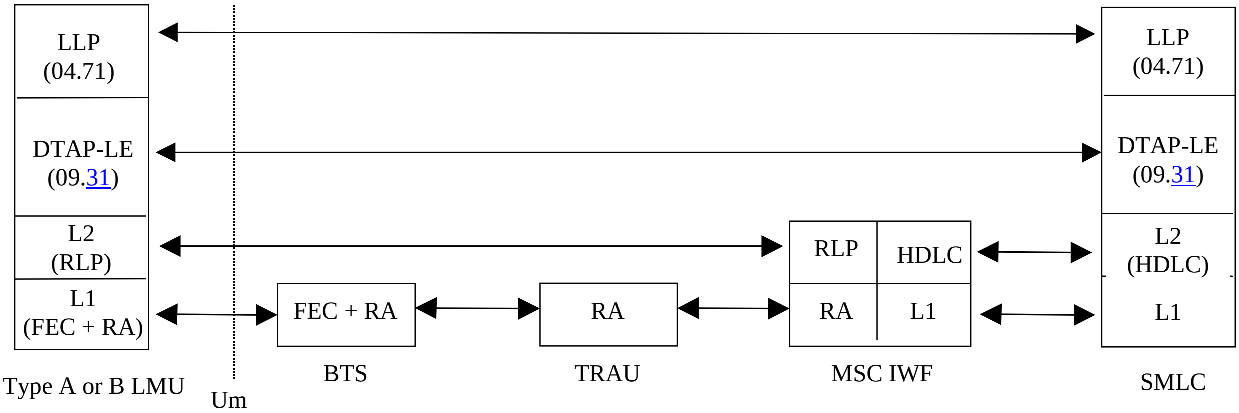


Figure 15~~Figure 12 –~~ Signaling between an SMLC and a Type A LMU with NSS based SMLC using a TCH in non-transparent (NT) mode

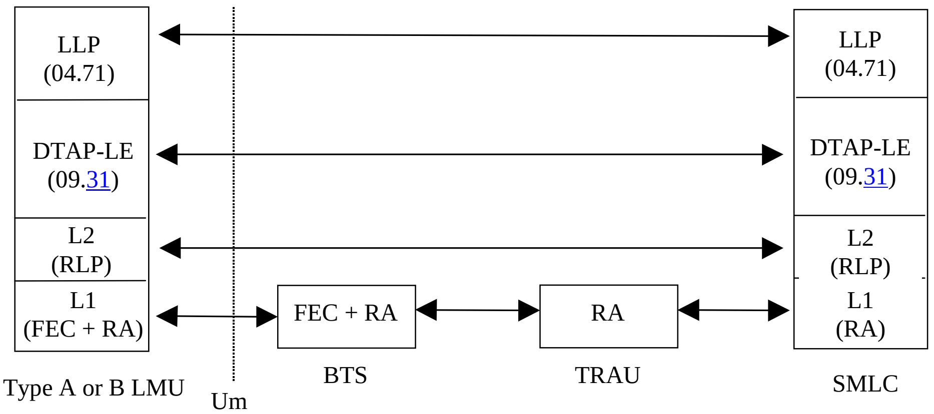


Figure 16~~Figure 13 –~~ Signaling between an SMLC and a Type A LMU with BSS based SMLC using a TCH

6.5 4.5 SMLC signaling to a Type B LMU

The protocol layers employed to enable signaling between the SMLC and a type B LMU are shown in Figures 14 and 15.

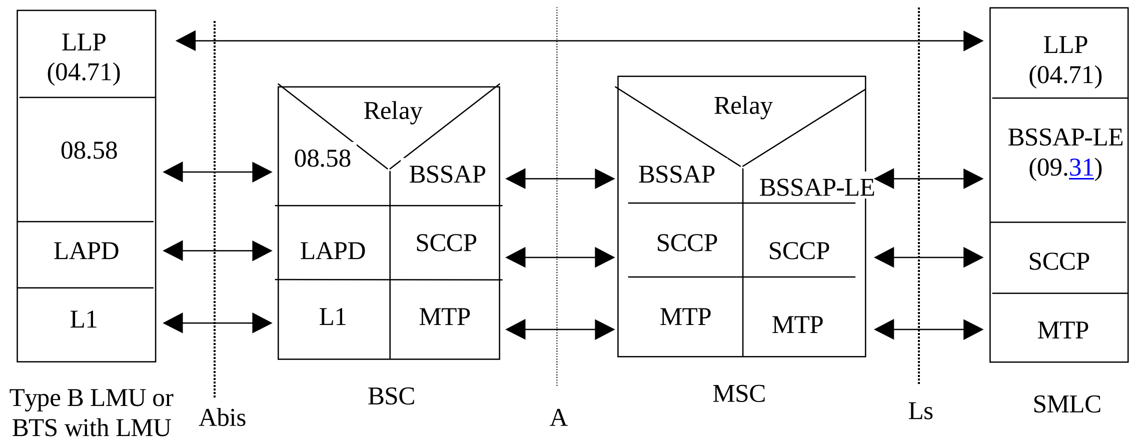


Figure 17 Figure 14 – Signaling between an SMLC and a Type B LMU with NSS based SMLC

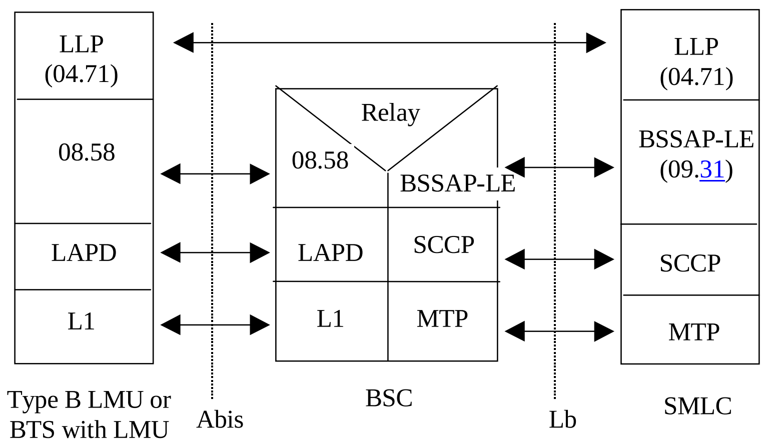


Figure 18 Figure 15 – Signaling between an SMLC and Type B LMU with BSS based SMLC

6.6 4.6 SMLC Signaling to a peer SMLC

The protocol layers used for SMLC to SMLC signaling are shown in Figure 16, where it is assumed that both SMLCs have SS7 link connections to STPs (or there is a direct SS7 link between the SMLCs). In the absence of either a direct link or links to an STP, signaling can go via attached BSCs and MSCs as shown in Figure 17 for signaling between BSS based SMLCs sharing the same MSC and in Figure 18 for signaling between a BSS based SMLC and an NSS based SMLC associated with different MSCs.

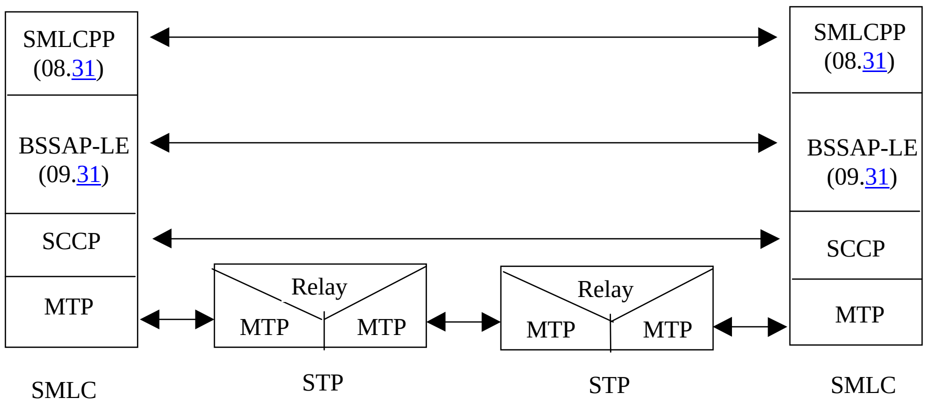


Figure 19 ~~Figure 16~~ - SMLC to SMLC Signaling via SS7 STPs

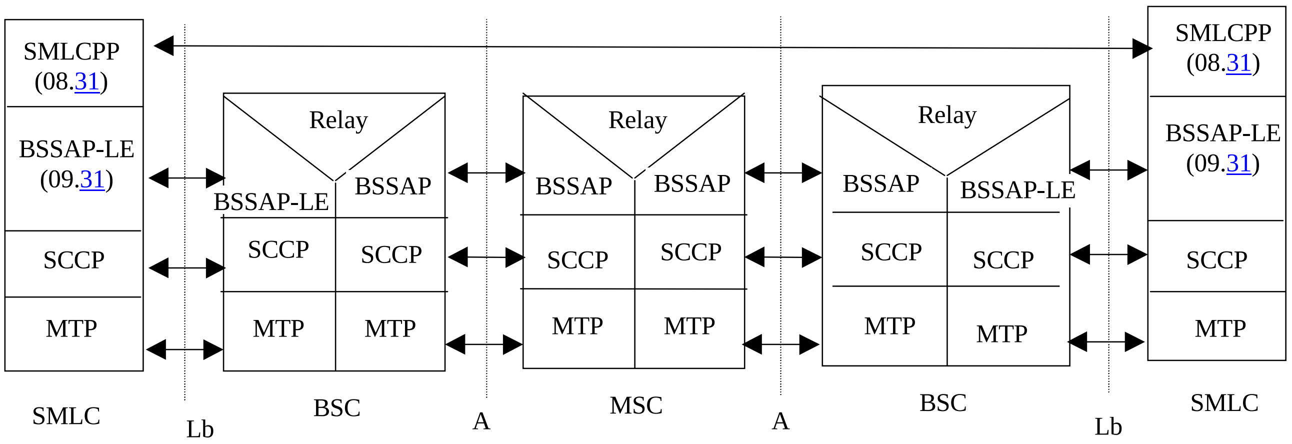


Figure 20 ~~Figure 17~~ SMLC to SMLC Signaling via associated BSCs and MSC (BSS based SMLCs)

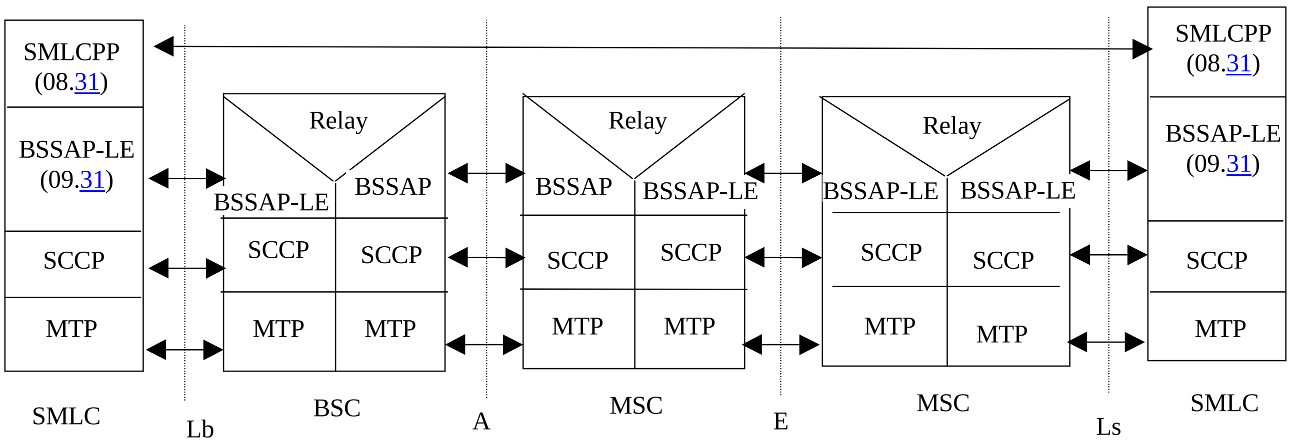


Figure 21 ~~Figure 18 –~~ SMLC to SMLC Signaling via BSC and MSCs (BSS to NSS based SMLC)

~~6.~~7 General Network Location Procedures

~~6.1.~~7.1 State Description for the GMLC

~~6.1.1.~~7.1.1 GMLC States

~~6.1.1.1~~7.1.1.1 NULL State

In the NULL state, a particular location request from some LCS client either has not been received yet or has already been completed. After a location request is received from a LCS client, the GMLC remains in the NULL state while the identity of the client and nature of its location request are verified. . While the NULL state exists conceptually, it need not be represented explicitly in the GMLC.

~~6.1.1.2~~7.1.1.2 INTERROGATION State

In this state, the GMLC has sent an interrogation to the home HLR of the MS to be located and is awaiting a response giving the VMSC address and IMSI for this MS.

~~6.1.1.3~~7.1.1.3 LOCATION State

In this state, the GMLC has sent a location request to the VMSC serving the MS to be located and is awaiting a response containing a location estimate.

~~6.1.2.~~7.1.2 State Functionality

~~6.1.2.1~~7.1.2.1 State Transitions

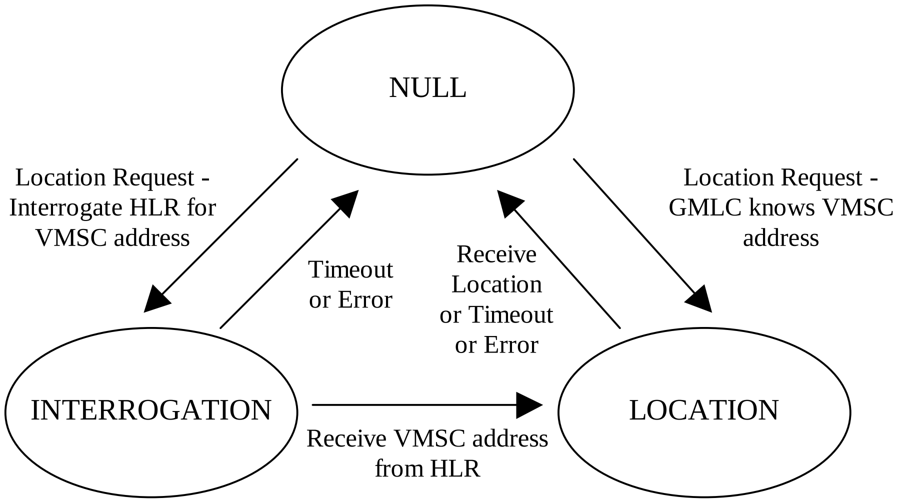


Figure 22~~6~~4 State Transitions in the GMLC

Moving from NULL to INTERROGATION state:

If the GMLC does not know the VMSC address or MS IMSI when it receives a location service request from some LCS client, it moves from the NULL state to the INTERROGATION state and sends a request to the MS's home HLR for the VMSC address and IMSI.

Moving from NULL to LOCATION state:
If the GMLC already knows both the VMSC address and MS IMSI when it receives a location service request from some LCS client (e.g. from information retained for an earlier location request for the same MS), it moves from the NULL state to the LOCATION state and sends a location request to the VMSC.

Moving from INTERROGATION to LOCATION state:
After the GMLC, in the INTERROGATION state, receives the VMSC address and IMSI from the home HLR, it enters the LOCATION state and sends a location request to the VMSC of the MS being located.

Moving from LOCATION to NULL state:
After the GMLC receives a location estimate response from the VMSC, it forwards the location estimate to the requesting LCS client and reenters the NULL state.

6.1.2.27.1.2.2 INTERROGATION Timer Function

The GMLC runs a timer while in the INTERROGATION state to limit the amount of time waiting for an interrogation response from the HLR. If the timer expires before an interrogation response is received, the GMLC indicates a location failure to the LCS client and reenters the NULL state.

6.1.2.37.1.2.3 LOCATION Timer Function

The GMLC runs a timer while in the LOCATION state to limit the amount of time waiting for a location estimate response from the VMSC. If the timer expires before a response is received, the GMLC indicates a location failure to the LCS client and reenters the NULL state.

6.2.7.2 State Description for the VMSC

6.2.1.7.2.1 VMSC States

6.2.1.17.2.1.1 IDLE State

In this state, the VMSC location service is inactive for a particular MS. The MS may be known in the VLR (except for a SIMless Emergency call or where the MS record has been canceled or lost in the VLR), but there may not be an active Mobility Management or Radio Resource connection to the MS.

6.2.1.27.2.1.2 LOCATION State

In this state, the VMSC is awaiting a response from theeither an NSS based SMLC or BSC after requesting the location for a particular MS. In this state, a Radio Resource connection, and a Mobility Management connection and the LCS layer of the Connection Management connection to the target MS will be active – allowing the SMLC and MS to exchange positioning related messages for mobile based and mobile assisted position methods. For certain position methods (e.g. network based position methods), the SMLC may invoke substates in the VMSC during which other types of association are maintained with the MS (e.g. temporary call establishment). Such substates are defined in later sections for each positioning method. In this state, the VMSC may also transfer positioning related messages between an NSS basedthe SMLC and the target MS and/or between an NSS based SMLC and certainthose LMUs served by the VMSC.

6.2.1.37.2.2 State Functionality

6.2.1.47.2.2.2 State Transitions

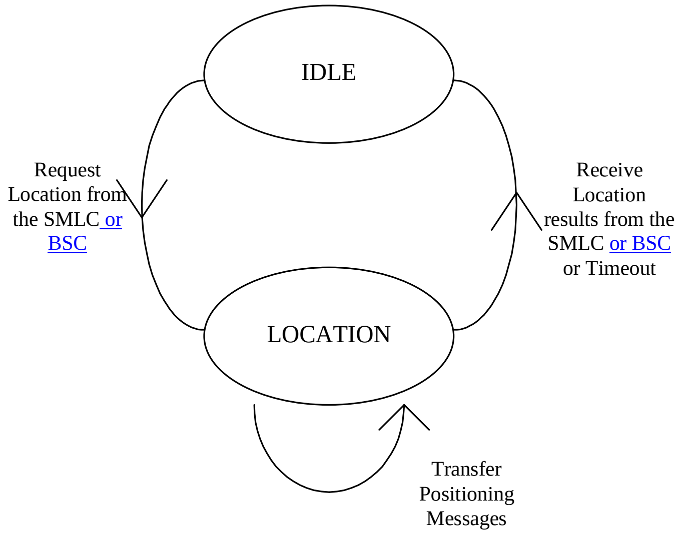


Figure 2475 State Transitions in the VMSC

Moving from IDLE to LOCATION state:
After a request has been received to locate a particular MS and the MS subscription options have been verified, a location request is sent to the SMLC or BSC associated with the serving cell of the MS to be located: the VMSC then enters the LOCATION state. Before entering this state, the VMSC must have obtained the current cell ID and TA value for the MS and setup a Radio Resource, and Mobility Management and a Connection Management connection to the MS if none was previously active.

Moving from LOCATION to IDLE state:
After the return of a location estimate result from the SMLC or BSC, the VMSC shall reenter IDLE state.

6.2.1.57.2.2.3 LOCATION Timer Function

The VMSC runs a timer while in the LOCATION state to limit the amount of time waiting for a location response from the SMLC or BSC. If the timer expires before such information is received, the VMSC indicates a location failure to the original requesting entity and reenters IDLE state.

7.3.7.3 State Description for the BSC

7.3.1.7.3.1 BSC States

7.3.1.17.3.1.1 IDLE State

In this state, the BSC location service is inactive for a particular MS.

7.3.1.2 LOCATION State

In this state, the BSC is awaiting a response from a BSS based SMLC or the VMSC after requesting the location for a particular MS. In this state, a Radio Resource connection to the target MS will be active – allowing the SMLC and MS to exchange positioning related messages for mobile based and mobile assisted position methods. For certain position methods (e.g. network based position methods), the SMLC may invoke substates in the BSC during which other types of association or procedure are supported with the MS (e.g. temporary call establishment, handover). Such substates are defined in later sections for each positioning method. In this state, the BSC may transfer positioning related messages between the SMLC and the target MS and/or between the SMLC and certain LMUs served by the BSC.

~~7.3.1.3~~7.3.2 State Functionality

~~7.3.1.4~~7.3.2.2 State Transitions

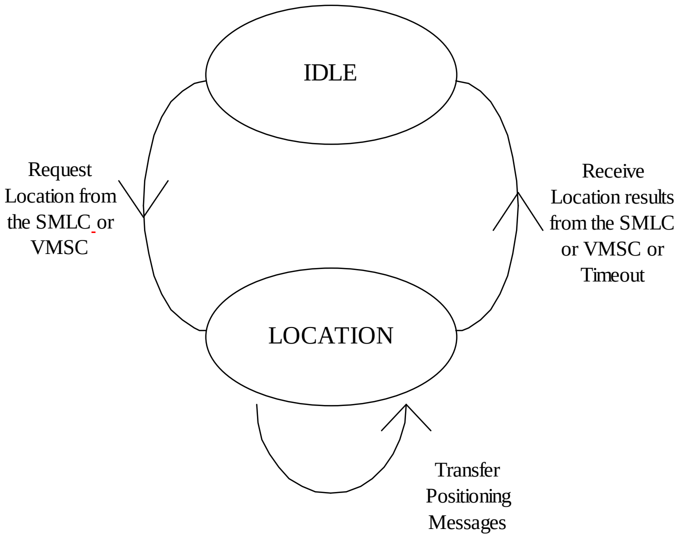


Figure 26~~86~~ State Transitions in the BSC

Moving from IDLE to LOCATION state:
After a request has been received (e.g. from the VMSC or from a client internal to the BSC) to locate a particular MS served by the BSC, a location request is sent to either the BSS based SMLC associated with the serving cell or to the VMSC (with an NSS based SMLC): the BSC then enters the LOCATION state. Before entering this state, a Radio Resource connection to the MS must have been already established by the VMSC.

Moving from LOCATION to IDLE state:
After the return of a location estimate result from the SMLC or VMSC, the BSC shall reenter IDLE state.

~~7.3.1.5~~7.3.2.3 LOCATION Timer Function

The BSC runs a timer while in the LOCATION state to limit the amount of time waiting for a location response from the SMLC or VMSC. If the timer expires before such information is received, the BSC indicates a location failure to the original requesting entity and reenters IDLE state.

~~6.3.~~7.4 State Description for the SMLC

~~6.3.1.~~7.4.1 SMLC States

~~6.3.1.1~~7.4.1.1 NULL State

This is a conceptual rather than actual state in which a certain location request from a particular VMSC or BSC either has not yet been received or has been completed.

~~6.3.1.2~~7.4.1.2 LOCATION State

This state exists after the SMLC has received a location request from a VMSC or BSC and persists while the SMLC is obtaining position measurements for a particular positioning method until such time as positioning measurements have been received and a location estimate has been computed and returned to the VMSC or BSC.

When sufficient positioning measurement results have been received, the SMLC either evaluates them, if they include an already computed location estimate, or uses them to compute a location estimate. The SMLC then has the option of either reinitiating another positioning attempt, if the location estimate did not satisfy the required QoS, or returning the location estimate to the VMSC or BSC.

6.3.2.7.4.2 State Functionality

6.3.2.17.4.2.2 State Transitions

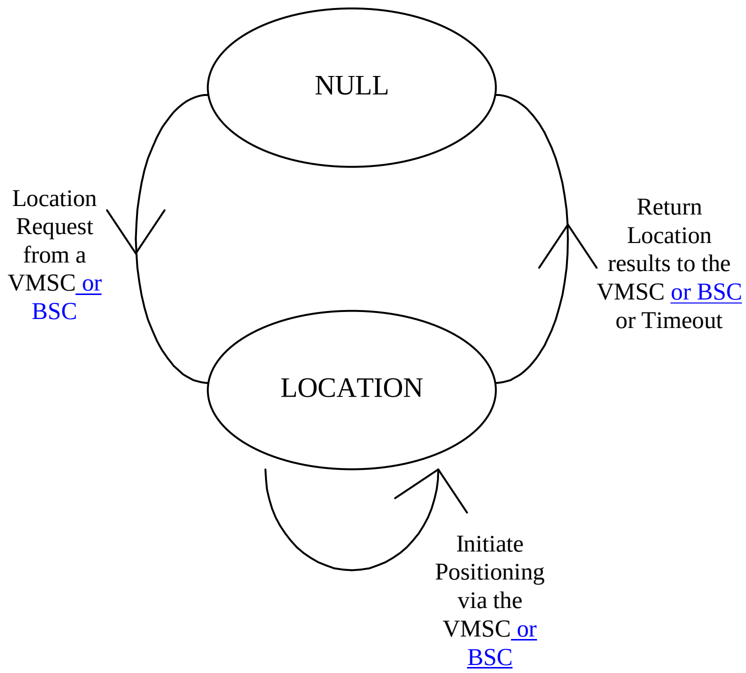


Figure 2897 State Transitions in the SMLC

Moving from NULL to LOCATION state:
After a location request is received from the VMSC or BSC, the SMLC chooses a positioning method and initiates the appropriate position measurements. It then enters the LOCATION state.

Moving from LOCATION to NULL state:
When the SMLC has obtained a location estimate that best meets the requested QoS parameters, it returns this to the VMSC or BSC and reenters the NULL state.

6.3.2.27.4.2.3 LOCATION Timer Function

The SMLC runs a timer while in the LOCATION state to limit the total amount of time that positioning can be active. This timer should be related to any response time indicated in the location request QoS parameters. If the timer expires before a final location estimate has been produced, the SMLC either returns the best existing location estimate to the VMSC or BSC (e.g. an estimate based on the current cell ID) or returns a failure indication. It then reenters the NULL state.

7.5 Usage of SCCP Connections on the Ls and Lb interfaces

SCCP connection oriented signaling between and SMLC and MSC (NSS based SMLC) or SMLC and BSC (BSS based SMLC) is used to support SMLC signaling to a type A LMU, serving BSC, serving MSC orand target MS. Two distinct types of SCCP connection are needed.:

7.5.1 ~~6.1~~ SCCP connection for positioning of a target MS

The MSC and BSC set up this connection when they request a location estimate for a target MS. The MSC/BSC sends the BSSMAP-LE Perform Location Request to the SMLC inside an SCCP Connection Request message. Signaling between the SMLC and target MS is then relayed by the serving MSC or BSC between this SCCP connection and the main signaling link to the MS. The same SCCP connection is also used to transfer BSSLAP messages between the SMLC and serving BSC. See Figures 19 and 20.

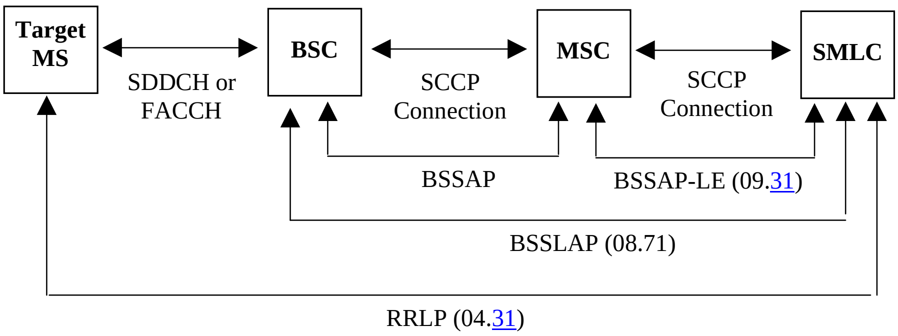


Figure 30 ~~Figure 19~~ – SCCP based signaling for MS positioning with an NSS based SMLC

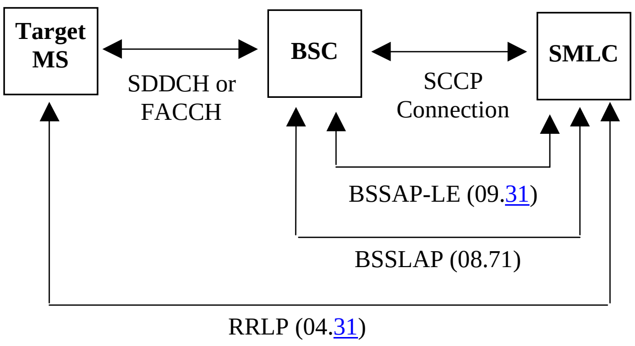


Figure 31 ~~Figure 20~~ – SCCP based signaling for MS positioning with a BSS based SMLC

7.5.2 ~~6.2~~ SCCP connection to access a type A LMU

The MSC, BSC or SMLC setup this connection to enable LCS messages to be transferred to or from a type A LMU. The MSC, BSC or SMLC sends a BSSMAP-LE ~~Open~~ LMU Connection Request message inside an SCCP Connection Request message. Signaling is subsequently relayed through the serving MSC and BSC using this SCCP connection as shown in Figures 21 and 22.

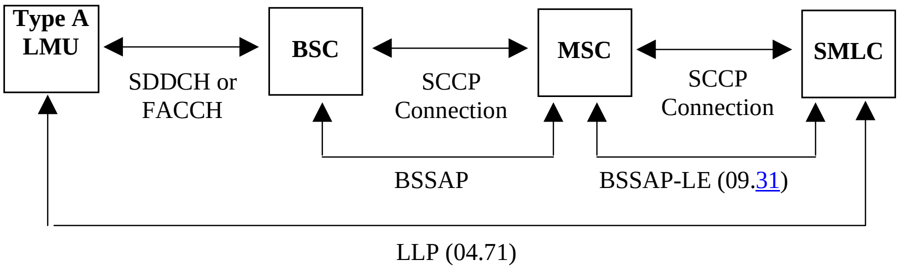


Figure 32~~Figure 21~~ – SCCP based signaling to access a type A LMU with an NSS based SMLC

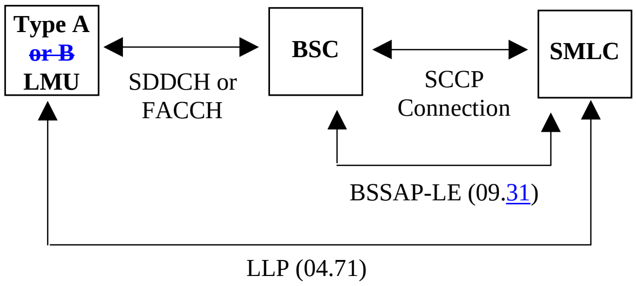


Figure 33~~Figure 22~~ – SCCP based signaling to access a type A LMU with a BSS based SMLC

~~6.4.~~7.6 General Network Positioning Procedures

The generic network positioning procedure of providing the location information of an MS subscriber can be partitioned into the following procedures:

Location Preparation Procedure

This generic procedure is concerned with verifying the privacy restrictions of the MS subscriber, reserving network resources, communicating with the MS to be located and determining the positioning method to be used for locating the MS subscriber based on the requested QoS and the MS and network capabilities.

Positioning Measurement Establishment Procedure

This procedure is concerned with performing measurements by involving the necessary network and/or MS resources. Depending on the positioning method to be used for locating the MS the internals of this procedure can be positioning method dependent. The procedure is completed with the end of the positioning measurements.

Location Calculation and Release Procedure

This generic procedure is initiated after the measurements are completed and is concerned with calculating the location of the MS and releasing all network and/or MS resources involved in the positioning.

~~6.4.1.~~7.6.1 Mobile Terminating Location Request (MT-LR)

Figure 23 illustrates general network positioning for LCS clients external to the PLMN. In this scenario, it is assumed that the target MS is identified using either an MSISDN or IMSI.

~~**Editorial Remark:** it was suggested in Cambridge not to show the onward transfer of a position request from the BSC to a BSS based SMLC but to include this in the message flows for particular position methods. Here it is preferred to include this in the generic flow in order to avoid a discontinuity with the positioning procedure in the SMLC (since step 8 depends on the~~

SMLC receiving the positioning request). The small amount of extra signaling this entails is not considered very significant. It was agreed in Dallas (July 6-9) to use dotted lines to distinguish SMLC access via a BSC.

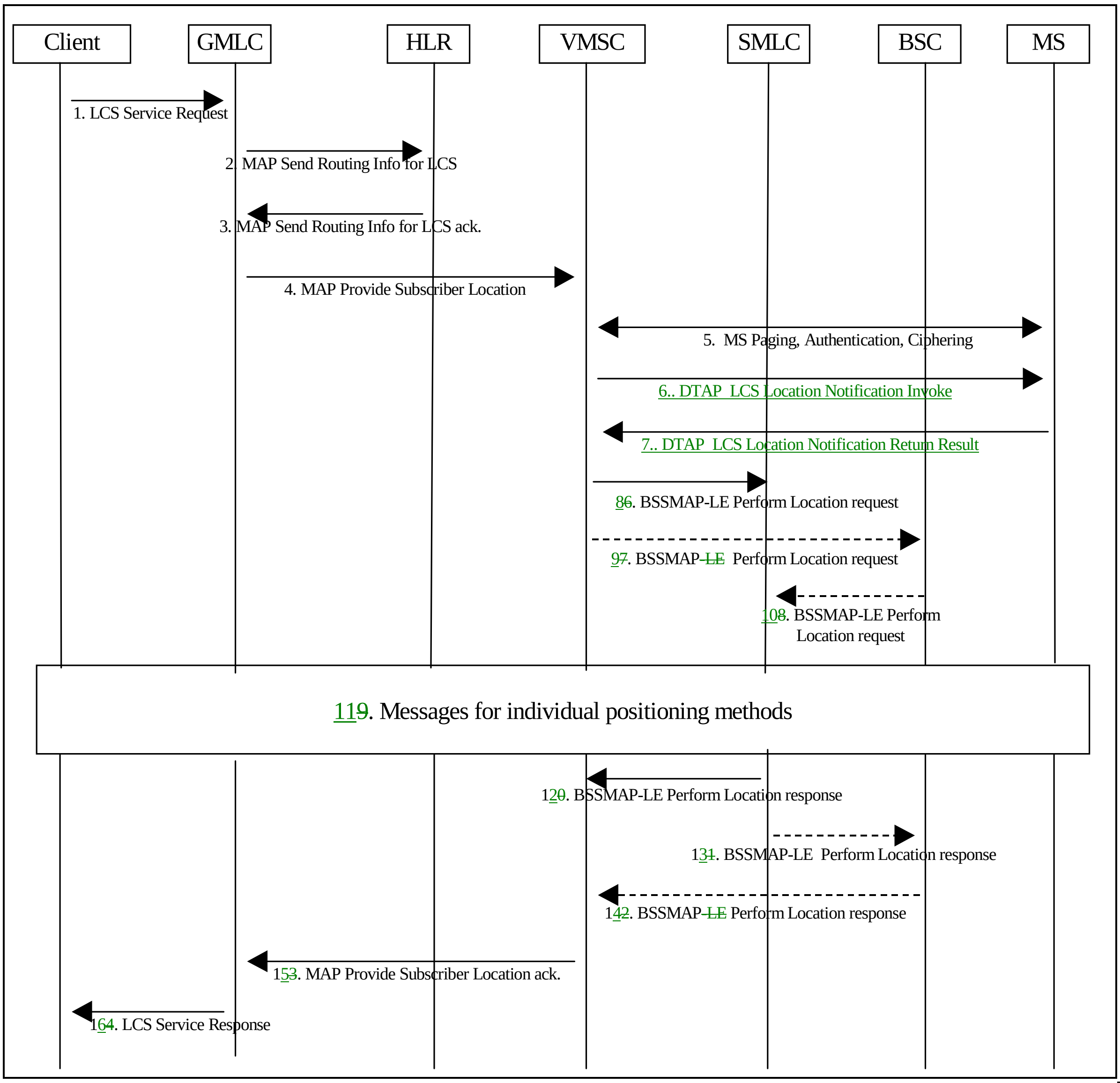


Figure 23 General Network Positioning for a MT-LR

7.6.1.1 Location Preparation Procedure

(1) An external LCS client requests the current location and possibly the velocity of a target MS from a GMLC. The GMLC verifies the identity of the LCS client and its subscription to the LCS service requested and derives the MSISDN or IMSI of the target MS to be located and the LCS QoS from either subscription data or data supplied by the LCS client. For a call related location request, the GMLC obtains and authenticates the called party number of the LCS client (refer to Annex A for further details). If location is required for more than one MS, or if periodic location is requested, steps 2 to 12 below may be repeated.

(2) If the GMLC already knows both the VMSC location and IMSI for the particular MSISDN (e.g. from a previous location request), this step and step 3 may be skipped. Otherwise, the GMLC sends a MAP_SEND_ROUTING_INFO_FOR_LCS message to the home HLR of the target MS to be located with either the IMSI or MSISDN of this MS.

(3) The HLR verifies that the SCCP calling party address of the GMLC, corresponds to a known GSM network element that is authorized to request MS location information. The HLR then returns the current VMSC address and whichever of the IMSI and MSISDN was not provided in step (2) for the particular MS.

(4) The GMLC sends a MAP_PROVIDE_SUBSCRIBER_LOCATION message to the VMSC indicated by the HLR. This message carries the type of location information requested (e.g. current location and possibly velocity), the MS subscriber's IMSI, LCS QoS information (e.g. accuracy, response time~~, preferred/required positioning method~~) and an indication of whether the LCS client has the override capability. For a call related location request, the message also carries the LCS client's called party number. The message may optionally carry the identity of the LCS client.

(5) If the GMLC is located in another PLMN or another country, the VMSC first authenticates that a location request is allowed from this PLMN or from this country. If not, an error response is returned. If the target MS has an established circuit call other than speech, the location request may be~~is~~ denied and an error response is then returned to the GMLC[1]. If the location request is allowed for a non-speech circuit call, it shall be up to the SMLC to decide, on the basis of the applicable position methods and requested QoS, whether positioning is possible. ~~Otherwise, t~~The VMSC then verifies LCS barring restrictions in the MS user's subscription profile in the VLR. In verifying the barring restrictions, barring of the whole location request is assumed if any part of it is barred or any requisite condition is not satisfied. If LCS is to be barred without notifying the target MS and a LCS client accessing a GMLC in the same country does not have the override capability, an error response is returned to the GMLC. Otherwise, if the MS is in idle mode, the VLR performs paging, authentication and ciphering. This procedure will provide the MS user's current cell ID and certain location information that includes the TA value in the BSSMAP Complete layer 3 Information used to convey the Paging Response. If the MS is instead in dedicated mode, the VMSC will have been supplied with the current cell ID from either the serving BSC or serving MSC in the case of an established call with MSC-MSC handover.

(6) If the location request comes from a value added LCS client and the MS subscription profile indicates that the MS must either be notified or notified with privacy verification and the MS supports notification of LCS (according to the MS Classmark 2), a DTAP LCS Location Notification Invoke message is sent to the target MS indicating the type of location request (e.g. current location possibly with velocity), the identity of the LCS client and whether privacy verification is required. Optionally, the VMSC may after sending the DTAP LCS Location Notification~~Privacy Verification~~ Invoke message continue in parallel the location process, i.e. continue to step (8) without waiting for a DTAP LCS Location Notification~~Privacy Verification~~ Return Result message in step (7).

(7) The target MS notifies the MS user of the location request and, if privacy verification was requested, waits for the user to grant or withhold permission. The MS then returns a DTAP LCS Location Notification Return Result to the VMSC indicating, if privacy verification was requested, whether permission is granted or denied. Optionally, the DTAP LCS Location Notification~~Privacy Verification~~ Return Result message can be returned some time after step (6), but before step (15). If the MS user does not respond after a predetermined time period, the VMSC shall infer a "no response" condition. The VMSC shall return an error response to the GMLC if privacy verification was requested and either the MS user denies permission or there is no response with the MS subscription profile indicating barring of the location request.

(8) The VMSC sends a BSSMAP-LE PERFORM LOCATION request message to the SMLC associated with the MS's current cell location if the SMLC is NSS based. This message is transported inside an SCCP Connection Request message. The BSSMAP-LE message includes the type of location information requested, the MS's location capabilities and currently assigned radio channel type (SDCCH, TCH-FR or TCH-HR), the requested QoS and the current Cell ID and, if available, any location information including the TA value received in step 5.

(9) If the SMLC is BSS based, the VMSC instead sends the BSSMAP~~-LE~~ PERFORM LOCATION message to the serving BSC for the target MS.

(10) In the case of a BSS based SMLC, the BSC forwards the BSSMAP-LE PERFORM LOCATION request received in step 9~~7~~ to the SMLC. The BSC may add additional measurement data to the message to assist with positioning. The message is transported inside an SCCP connection request.

7.6.1.2 Positioning Measurement Establishment Procedure

(11) If the requested location information and the location accuracy within the QoS can be satisfied by the reported cell ID and, if available, TA value, the SMLC may send a BSSMAP-LE PERFORM LOCATION response immediately. Otherwise, the SMLC determines the positioning method and instigates the particular message sequence for this method defined in subsequent sections. If the position method returns position measurements, the SMLC uses them to compute a location estimate and, possibly, a velocity estimate. If there has been a failure to obtain position measurements, the SMLC may use the current cell ID and, if available, TA value to derive an approximate location estimate. If an already computed location estimate is returned for an MS based position method, the SMLC may verify consistency with the current cell ID and, if available, TA value. If the location estimate so obtained does not satisfy the requested accuracy and sufficient response time still remains, the SMLC may instigate a further location attempt using the same or a different position method. If velocity and location are requested but the SMLC can only obtain location, this may be returned

~~[1] It was pointed out in Cambridge that in phase 2, this restriction should be removed.~~

without the velocity. If a vertical location coordinate is requested but the SMLC can only obtain horizontal coordinates, these ~~alone~~ may be returned.

7.6.1.3 Location Calculation and Release Procedure

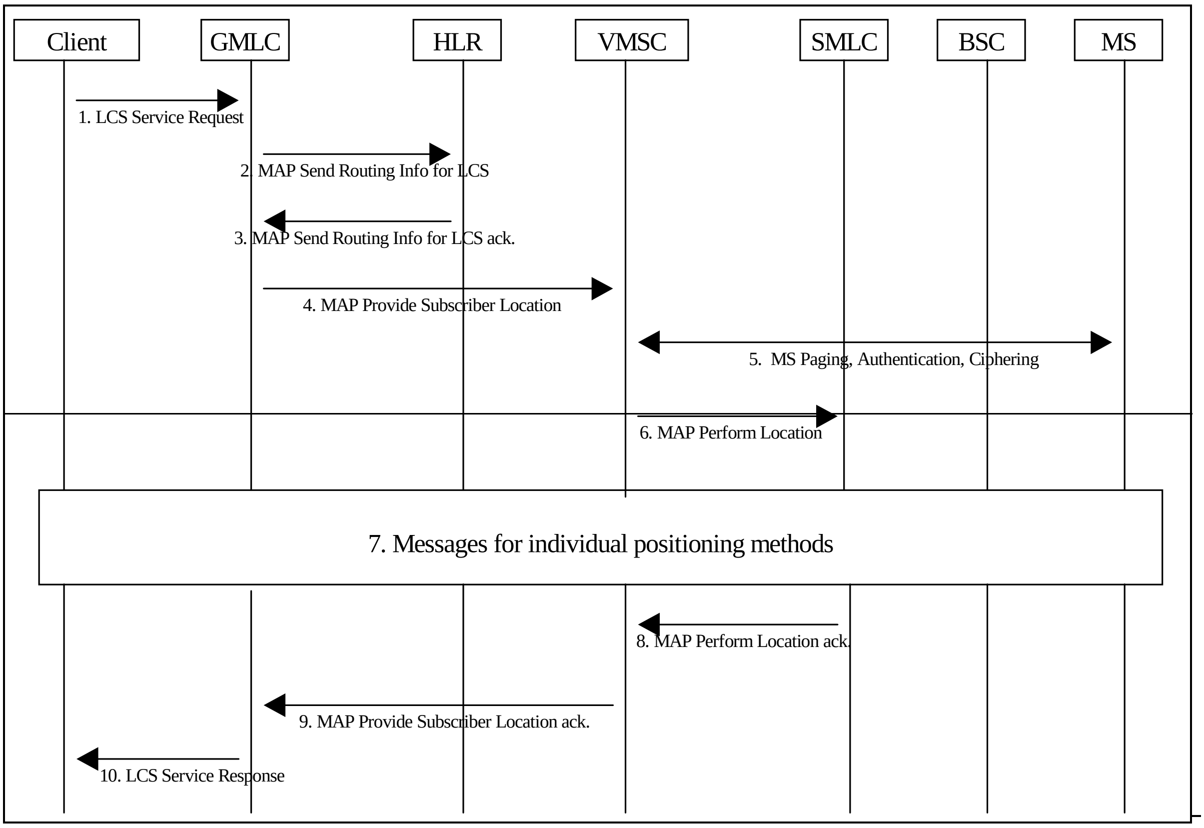
(12) When ~~a~~ location information~~estimate~~ best satisfying the requested location type and QoS has been obtained, the SMLC returns it to the VMSC in a Perform Location response if the SMLC is NSS based. If a location estimate could not be obtained, the SMLC returns a Perform Location response containing a failure cause and no location estimate.

(13) For a BSS based SMLC, the location information~~estimate~~ is instead returned to the serving BSC.

(14) In the case of a BSS based SMLC, the BSC forwards the BSSMAP PERFORM LOCATION response received in step 13~~1~~ to the VMSC.

(15) The VMSC returns the location information~~estimate~~ and its age to the GMLC, if the VMSC has not initiated the Privacy Verification process in step (6). If step (6) has been performed for privacy verification, the VMSC returns the location information only, if it has received a DTAP LCS Location Notification~~Privacy Verification~~ Return Result indicating that permission is granted. If a DTAP LCS Location Notification~~Privacy Verification~~ Return Result~~Error~~ message indicating that permission is not granted is received, or there is no response with the MS subscription profile indicating barring of location~~a DTAP LCS Privacy Verification Return Result is not received after a predetermined time period~~, the VMSC shall return an error response to the GMLC. If the SMLC did not return a successful location estimate, but the privacy checks in steps 5-7 were successfully executed, the VMSC may return the last known location of the target MS if this is known and the LCS client is requesting the current or last known location. The VLR may then release the Mobility Management connection to the MS, if the MS was previously idle, and the VMSC may record billing information.

(16) The GMLC returns the MS location information~~estimate~~ to the requesting LCS client. If the LCS client requires it, the GMLC may first transform the universal location coordinates provided by the VMSC into some local geographic system. The GMLC may record billing for both the LCS client and inter-network revenue charges from the VMSC's network.



~~**Figure 7 General Network Positioning for a MT-LR**~~

~~6.4.1.1Location Preparation Procedure~~

~~(1) An external LCS client requests the current location of a target MS from a GMLC. The GMLC verifies the identity of the LCS client and its subscription to the LCS service requested and derives the MSISDN or IMSI of the target MS to be located and the LCS QoS from either subscription data or data supplied by the LCS client. For a call related location request, the GMLC obtains and authenticates the called party number of the LCS client (refer to Annex A for further details). If location is required for more than one MS, or if periodic location is requested, steps 2 to 12 below may be repeated.~~

~~(2) If the GMLC already knows both the VMSC location and IMSI for the particular MSISDN (e.g. from a previous location request), this step and step 3 may be skipped. Otherwise, the GMLC sends a MAP_SEND_ROUTING_INFO_FOR_LCS message to the home HLR of the target MS to be located with either the IMSI or MSISDN of this MS.~~

~~(3) The HLR verifies that the SCCP calling party address of the GMLC, corresponds to a known GSM network element that is authorized to request MS location information. The HLR then returns the current VMSC address and whichever of the IMSI and MSISDN was not provided in step (2) for the particular MS.~~

~~(4) The GMLC sends a MAP_PROVIDE_SUBSCRIBER_LOCATION message to the VMSC indicated by the HLR. This message carries the MS subscriber's IMSI, LCS QoS information (e.g. accuracy, response time, preferred/required positioning method) and an indication of whether the LCS client has the override capability. For a call related location request, the message also carries the LCS client's called party number. The message may optionally carry the identity of the LCS client.~~

~~**(5)** If the GMLC is located in another PLMN or another country, the VMSC first authenticates that a location request is allowed from this PLMN or from this country. If not, an error response is returned. If the target MS has an established circuit call other than speech, the location request is denied and an error response is returned to the GMLC. Otherwise, the VMSC then verifies LCS barring restrictions in the MS user's subscription profile in the VLR. If LCS is barred and a LCS client accessing a GMLC in the same country does not have the override capability, an error response is returned to the GMLC. Otherwise, if the MS is in idle mode, the VLR performs paging, authentication and ciphering. This procedure will provide the MS user's current cell ID and certain location information that includes the TA value in the BSSMAP Complete layer 3 Information used to convey the Paging Response. If the MS is instead in dedicated mode, the VMSC will have been supplied with the current cell ID from either the serving BSC or serving MSC in the case of an established call with MSC-MSC handover.~~

~~**(6)** The VMSC sends a MAP_PERFORM_LOCATION message to the SMLC associated with the MS's current cell location. This message includes the MS's location capabilities and currently assigned radio channel type (SDCCH, TCH-FR or TCH-HR), the requested QoS and the current Cell ID and, if available, any location information including the TA value received in step 5.~~

~~6.4.1.2Positioning Measurement Establishment Procedure~~

~~**(7)** If the requested location accuracy within the QoS can be satisfied by the reported cell ID and, if available, TA value, the SMLC may send a MAP_PERFORM_LOCATION ack. immediately. Otherwise, the SMLC determines the positioning method and instigates the particular message sequence for this method defined in subsequent sections. If the position method returns position measurements, the SMLC uses them to compute a location estimate. If there has been a failure to obtain position measurements, the SMLC may use the current cell ID and, if available, TA value to derive an approximate location estimate. If an already computed location estimate is returned for an MS based position method, the SMLC may verify consistency with the current cell ID and, if available, TA value. If the location estimate so obtained does not satisfy the requested accuracy and sufficient response time still remains, the SMLC may instigate a further location attempt using the same or a different position method.~~

~~6.4.1.3Location Calculation and Release Procedure~~

~~**(8)** When a location estimate best satisfying the requested QoS has been obtained, the SMLC returns it to the VMSC.~~

~~**(9)** The VMSC returns the location estimate and its age to the GMLC. The VLR may then release the Mobility Management connection to the MS, if the MS was previously idle, and the VMSC may record billing information.~~

~~**(10)** The GMLC returns the MS location estimate to the requesting LCS client. If the LCS client requires it, the GMLC may first transform the universal location coordinates provided by the VMSC into some local geographic system. The GMLC may record billing for both the LCS client and inter-network revenue charges from the VMSC's network.~~

6.4.2.7.6.2 MT-LR without HLR Query - applicable to North America Emergency Calls only

Figure 35 illustrates location for a North American Emergency Services call, where an emergency services client identifies the target MS using an IMSI, MSISDN or NA-ESRK plus, possibly IMEI, that were previously provided to it by the VMSC (e.g. see section 7.6.46.4.5). The emergency services client also identifies the VMSC to the GMLC by providing an NA-ESRD or NA-ESRK or by referring to information for the target MS already stored in the GMLC. This allows the GMLC to request location from the VMSC without first querying the home HLR of the target MS. This is necessary when the home HLR either cannot be identified (e.g. client provides an NA-ESRK but not IMSI or MSISDN) or does not support the LCS query procedure.

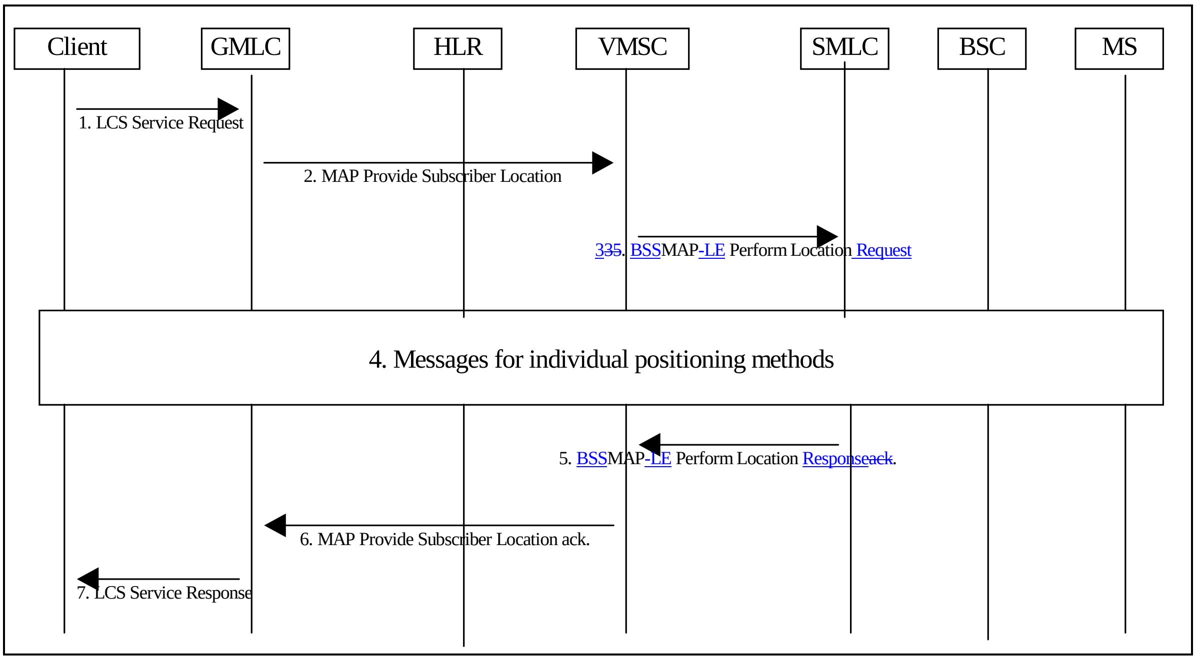


Figure 35119 Positioning for a Emergency Services MT-LR without HLR Query

(1) Same as step 1 in Figure 7 but with the LCS client identifying first the target MS by an IMSI, MSISDN or NA-ESRK and possibly IMEI and, second, the VMSC by an NA-ESRK or NA-ESRD.

(2) If the GMLC already has stored information for the target MS (e.g. from a prior location estimate delivery to the LCS client), the GMLC may determine the VMSC from this information. Otherwise, The GMLC determines the VMSC using the NA-ESRK or NA-ESRD – with use of the NA-ESRK taking priority over that of the NA-ESRD. The MAP_PROVIDE_SUBSCRIBER_LOCATION message sent to the VMSC carries the IMSI, MSISDN or NA-ESRK and, if provided, the IMEI for the target MS, as well as the required QoS and an override indication of a location request from an emergency services client. The VMSC identifies the target MS using the IMSI, MSISDN or NA-ESRK and, if provided, the IMEI.

(3) The VMSC verifies that MS privacy is overridden by the emergency services provider and that positioning is not prevented for other reasons (e.g. unreachable MS, inapplicable call type to the MS). The VMSC then sends a BSSMAP-LE Perform Location Request to the SMLC, either directly or via the BSC, as in steps 8-10 for a normal MT-LR.

(4) The SMLC performs positioning as in step 11 for a normal MT-LR.

(5) The SMLC returns a location estimate to the VMSC either directly or via the BSC as in steps 12-14 for a normal MT-LR.

(6) to (7) Same as steps 156 to 1610 for a normal MT-LRin Figure 7.

6.4.3.7.6.3 MT-LR for a previously obtained location estimate

Every time the location (and velocity) estimate of a target MS subscriber is returned by the SMLC to the VMSC, the VMSC may store the location (and velocity) estimate together with a time stamp in the subscriber's VLR record.

The time stamp is the time at which the location (and velocity) estimate is stored at the VLR i.e. after the SMLC returns the location (and velocity) estimate to the VMSC. The time stamp indicates the 'age' of the location (and velocity) estimate.

~~6.4.3.1~~7.6.3.1 Initial Location

In the context of an originating emergency call the location estimate and the associated time stamp at the commencement of the call set-up is referred to as *'initial location'*.

~~6.4.3.2~~7.6.3.2 Current Location

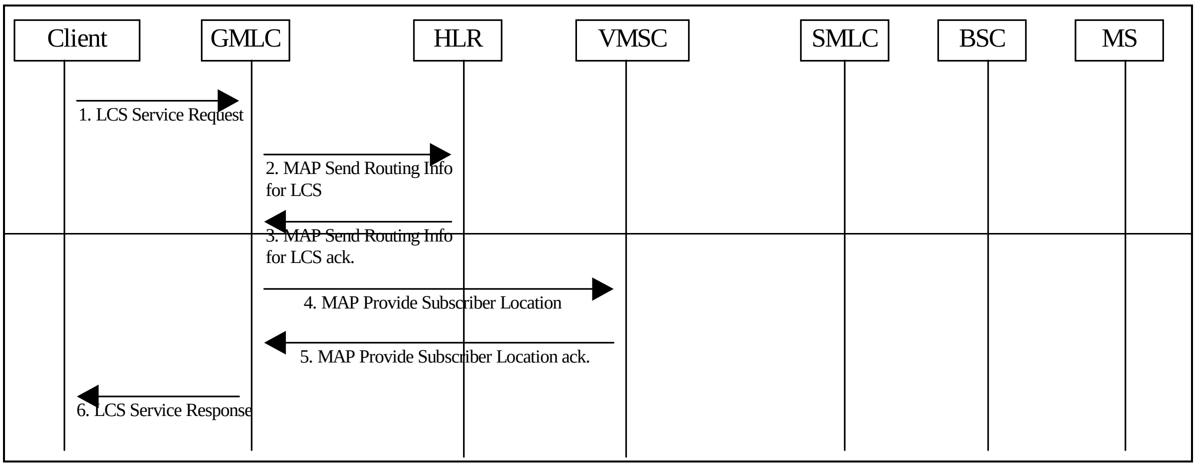
After a location attempt has succesfully del;ivered a location estimate and its assocoiated time stamp, the location estimate and time stamp is referred to as the 'current location' at that point in time.

~~6.4.3.3~~7.6.3.3 Last known Location

The current location estimate and its associated time stamp are stored in MSC/VLR and until replaced by a later location estimate and a new time stamp is referred to as the *'last known location'*. The last known location may be distinct from the initial location – i.e. more recent.

~~Figure 34 illustrates location where the VMSC does not invoke positioning but returns either a location estimate or a failure indication. This scenario is valid for the following types of location request:~~

- ~~Some time after an emergency services call has started, an emergency services client requests the initial location of the target MS at the start of the emergency call. (If the emergency call has just started, the VMSC may follow the procedure in Figure 7 to obtain the initial location).~~
- ~~A LCS client requests location with a "no delay" response time.~~



~~Figure 34~~1310 ~~MT-LR for a previously obtained location estimate~~

~~Same as step 1 in Figure 7, but with the LCS client requesting either the initial location for an emergency call or location with a "no delay" response time.~~
~~Same as step 2 in Figure 7. If the VMSC is identified using a NA-ESRK or NA-ESRD, then this step and step 3 are not needed.~~
~~Same as step 3 in Figure 7.~~
~~Same as step 4 in Figure 7. The message sent to the VMSC requests either an initial location or location with "no delay".~~
~~If the initial location for an emergency call is requested and the VMSC has previously obtained and stored this, this location estimate and its age are returned to the GMLC. Otherwise, if the initial location is not stored and this is not the start of the emergency call, a failure indication is returned. If location is requested with "no delay", the last known location currently stored in the VMSC and its age are returned; if no location is stored, a failure indication is returned.~~
(1) ~~Same as step 10 in Figure 7.~~

6.4.3.47.6.3.4 Security and Privacy

The handling of security and privacy of the target MS with regard to returning the last known or initial location estimate of the target MS shall be the same as when the target MS is reachable for positioning. (i.e. the requesting LCS client is authorized and the privacy of the target MS is secured before the VMSC check the VLR status of the target MS (i.e. whether the MS is marked as attached or detached in the VLR).

6.4.3.57.6.3.5 Failing to locate the target MS

In case of a 'Detached' or 'Not Reachable' target MS, the last known location (and velocity) and a time stamp stored at the VLR, may be returned to a LCS client requesting location information if the LCS client specifically requested the current or last known location (and velocity).- This does not apply to a value added LCS client where the target MS subscribes to notification of the location request: if the notification cannot be performed, the VMSC shall reject the location request.

Note: Due to CAMEL, the MSC/VLR may already be storing other location information parameters like location number, cell id, location area identity and VLR number in the subscriber's VLR record.

When a request for location information is received at the VMSC, the requested QoS shall indicate whether the 'last known location (and velocity) of the target MS' should be returned in case of a 'detached' or 'not reachable' target MS.

If the VLR has a valid copy of the subscriber's permanent data and the target MS's privacy settings are such that positioning is allowed, then the following two cases can occur.

6.4.3.5.17.6.3.5.1 Target MS is 'Not Reachable'

If the target MS is marked as 'attached' in the VLR, the VMSC orders paging of the target MS. If paging fails, due to target MS being 'not reachable' then VMSC shall check whether the LCS client has requested 'last known location (and velocity)' in case of 'not reachable' target MS.

If such a request exists and notification to the target MS does not apply for a value added LCS client, the VMSC shall include the last known location (and velocity) together with the time stamp available in its response to the request for location information.

An indicator of 'last known location' returned shall be marked at the CDR at VMSC.

6.4.3.5.27.6.3.5.2 Target MS is 'Detached'

If the target MS is marked as 'detached' in the VLR, the VMSC shall check whether the LCS client has requested 'last known location (and velocity)' in case of 'detached' target MS.
If such a request exists and notification to the target MS does not apply for a value added LCS client, the VMSC includes the 'last known location (and velocity)' together with the time stamp available in its response to the request for location information.
An indicator of 'last known location' returned shall be marked at the CDR at VMSC.

7.6.3.5.3 Target MS is Reachable but Positioning Fails

If the target MS is reachable (e.g. paging succeeds), but the VMSC is unable to obtain a current location (and velocity) estimate, the VMSC shall check whether the LCS client has requested 'last known location (and velocity)'.
If such a request exists and notification to the target MS either does not apply or was successfully executed for a value added LCS client, the VMSC includes the 'last known location (and velocity)' together with the time stamp available in its response to the request for location information.
An indicator of 'last known location' returned shall be marked at the CDR at VMSC.

6.4.3.5.37.6.3.5.4 Target MS is 'Purged'

If the target MS is marked as 'Purged' in HLR, then an indication 'Absent Subscriber' is returned to the GMLC.

6.4.4.7.6.4 Network Induced Location Request (NI-LR)

Figure 39illustrates positioning for an emergency service call.

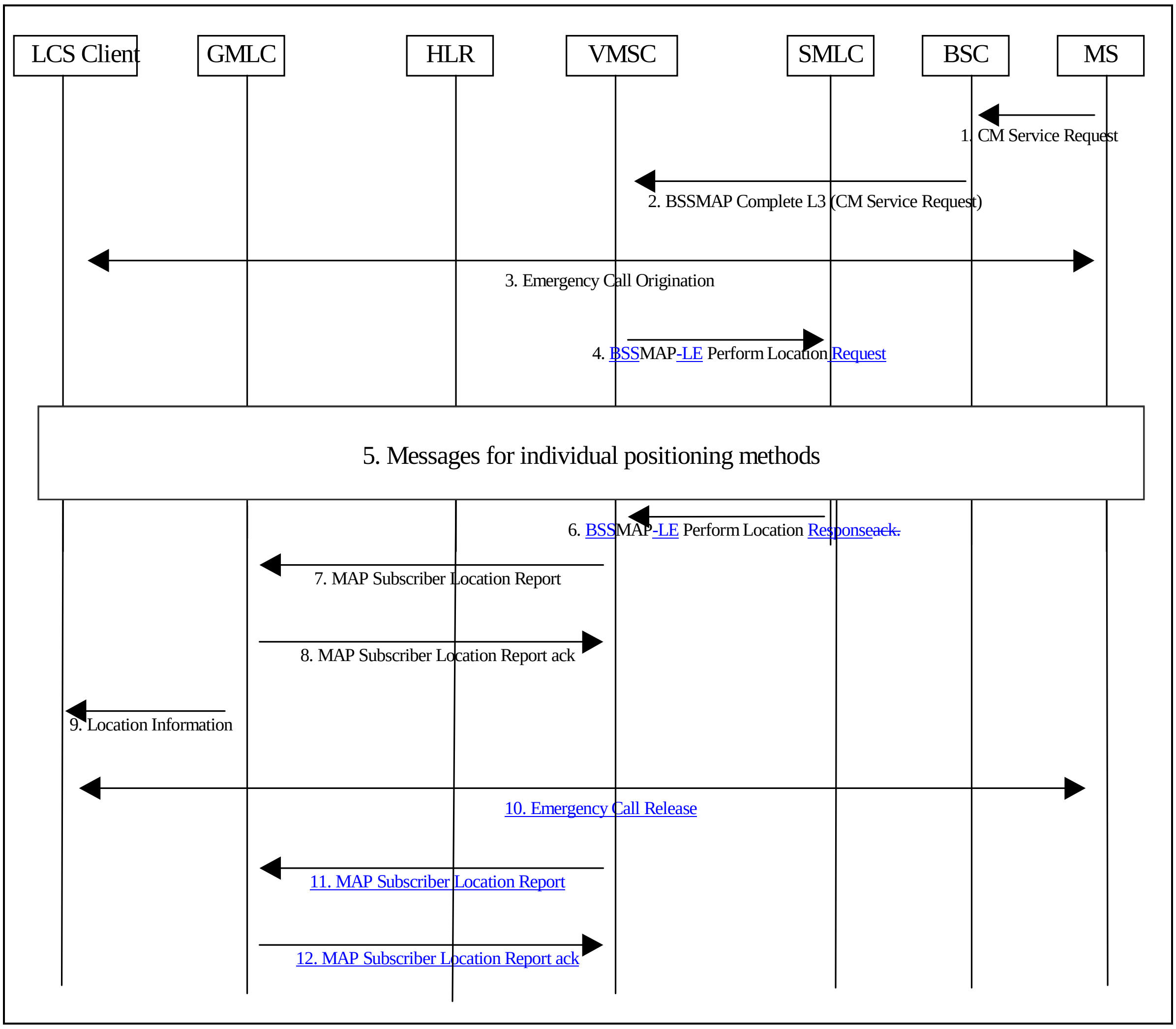


Figure 391511 Positioning for a NI-LR Emergency Service Call

6.4.4.17.6.4.1 Location Preparation Procedure

(1) An initially idle MS requests an SDCCH and sends a DTAP CM Service Request indicating a request for an Emergency Service call to the VMSC via the BSC.

(2) The BSC includes the current cell ID and may include certain other location information that includes(e.g. the TA value) within the BSSMAP Complete Layer 3 Information message used to convey the CM service request across the A-interface. The MS may identify itself using a TMSI, IMSI or IMEI.

(3) The VMSC, BSC and MS continue the normal procedure for emergency call origination towards the appropriate emergency services client. Depending on local regulatory requirements, the sending of call setup information into the PSTN may be delayed until either the MS's location has been obtained or the location attempt has failed or a PLMN defined timer has expired before location was obtained. Call setup information sent into the PSTN may include the MS location (if already obtained) plus information that will enable the emergency service provider to request MS location at a later time (e.g. NA-ESRD and NA-ESRK in North America).

(4) At any time after step 1, the VMSC may initiate procedures to obtain the MS's location. These procedures may run either in parallel with the emergency call origination or while emergency call origination is suspended to delay sending of call setup information into the PSTN according to step 3. The VMSC sends a BSSMAP-LE :Perform Location RequestMAP_PERFORM_LOCATION message to the SMLC associated with the MS's current location area – either directly or via the serving BSC (see steps 8-10 for an MT-LR). This message includes the MS's location capabilities and currently assigned radio channel type (SDCCH, TCH-FR or TCH-HR), the QoS required for an emergency call and the current Cell ID and any location information including the TA value received in step 2.

~~6.4.4.2~~7.6.4.2 Positioning Measurement Establishment Procedure

(5) The actions described under step 11~~7~~ for a MT-LR are performed. If a speech compatible traffic channel is required for network based positioning (e.g. TOA), the same traffic channel may be used for both the positioning and the emergency call. In that case, the traffic channel may be allocated by either the positioning procedure or emergency call origination procedure.

~~6.4.4.3~~7.6.4.3 Location Calculation and Release Procedure

(6) When a location estimate best satisfying the requested QoS has been obtained, the SMLC returns it to the VMSC – either dircetly or via the serving BSC (see steps 12-14 for an MT-LR).

(7) Depending on local regulatory requirements, the VMSC may send a MAP Subscriber Location report to a GMLC associated with the emergency services provider to which the emergency call has been or will be sent. This message shall carry any location estimate returned in step 6~~8~~, the age of this estimate and may carry the MSISDN, IMSI and IMEI of the calling MS. In North America, any NA-ESRD and any NA-ESRK that may have been assigned by the VMSC shall be included. The message shall also indicate the event that triggered the location report. If location failed (i.e. an error result was returned by the SMLC in step 8), an indication of failure rather than a location estimate may be sent to the GMLC: the indication of failure is conveyed by not including a location estimate in the MAP Subscriber Location Report.

(8) The GMLC acknowledges receipt of the location information. The GMLC may store the location information for later retrieval by the emergency services LCS client. If so, the acknowledgment to the MSC shall request notification when the emergency call has ended.

(9) The GMLC may optionally forward the~~any~~ information received in step 7 to the emergency services LCS client. For a North American emergency services call this client may be selected according to the NA-ESRD provided in step 7. ~~The GMLC may also store the information received in step 7 for later retrieval by the emergency services LCS client.~~

(10) ~~Depending on local regulatory requirements, steps 4 to 9 or steps 7 to 9 may be repeated at subsequent intervals – e.g. after the emergency call is answered and following release. In case of any notification following release, the GMLC and LCS client should release any call-related information (e.g. NA-ESRK) provided earlier.~~ At some later time, the emergency services call is released.

(11) If the GMLC requested notification of emergency call release in step 8, the MSC sends another MAP Subscriber Location Report to the GMLC. This message may include the same parameters as before except that there is no position estimate and an indication of emergency call termination is included.

(12) The GMLC acknowledges the MSC notification and may then release all information previously stored for the emergency call.

7.6.5 Network Induced Location Request (NI-LR) from a Serving BSC for a target MS in dedicated mode~~during an Established Call~~

Figure 24 illustrates how a serving BSC may obtain the location of a target MS that is already in dedicated mode ~~during an established call~~ on behalf of some PLMN operator LCS client – e.g. to support handover. ~~It is assumed that the serving MSC has already provided to the BSC both the subscription to the PLMN operator privacy class and the LCS capabilities of the target MS. This could be supported by additional parameters in certain BSSMAP messages – e.g. Assignment Request, Handover Command.~~ The procedure is valid for an NSS based SMLC in all circumstances and for a BSS based SMLC when local regulatory requirements do not require privacy checking for PLMN operator initiated location.

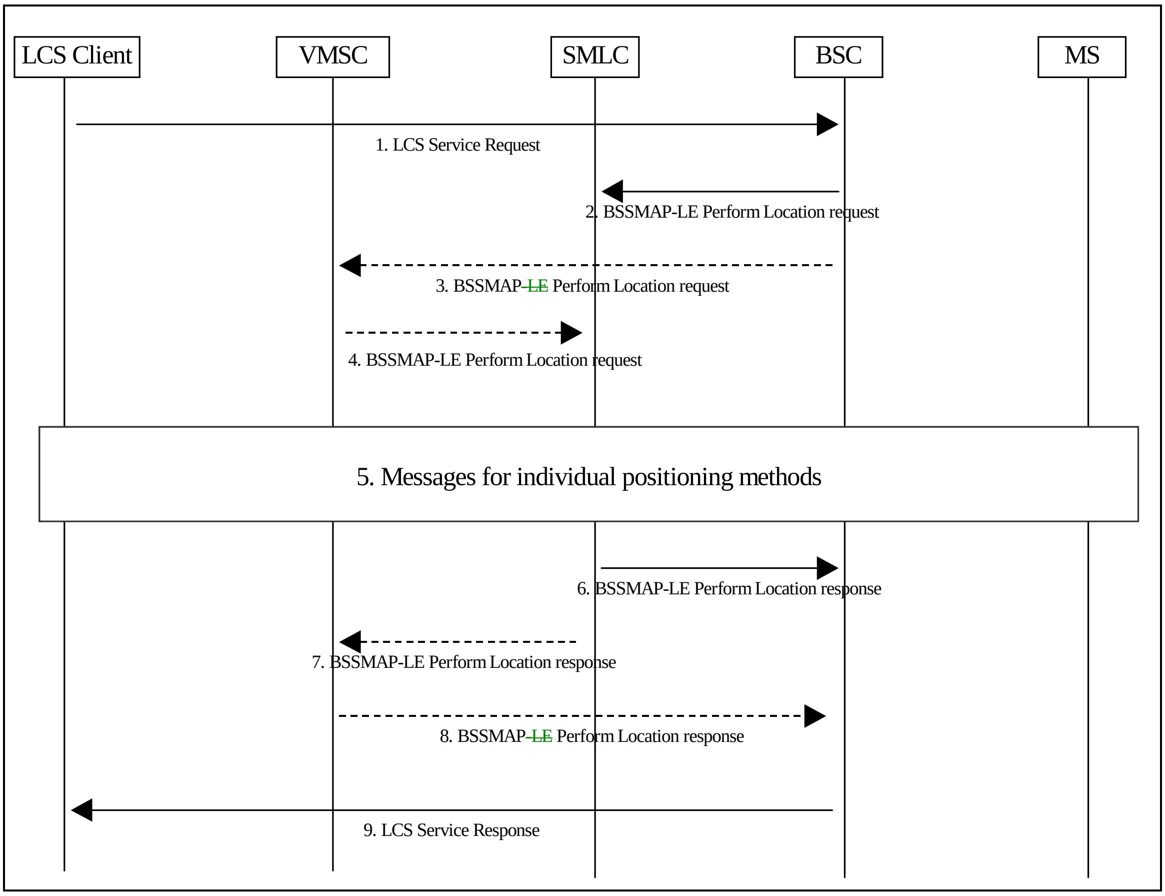


Figure 24 Network Induced Location Request from a Serving BSC

7.6.5.1 Location Preparation Procedure

(1) An LCS client within the BSC or within the PLMN requests the current location of a target MS from the serving BSC

(2) The BSC sends a BSSMAP-LE PERFORM LOCATION request message to the SMLC if this is BSS based. ~~This message is transported inside an SCCP Connection Request message~~ The BSSMAP-LE message includes the MS's location capabilities and currently assigned radio channel type (SDCCH, TCH-FR or TCH-HR), the requested QoS~~,~~ and the current Cell ID~~ and TA~~. The message may also contain additional measurements available to the BSC (e.g. TA value).

(3) If the SMLC is NSS based, the BSC instead sends the BSSMAP~~-LE~~ Perform Location Request to its serving MSC with the type of PLMN operator LCS client.

(4) In the case of an NSS based SMLC, the MSC verifies in the subscription profile of the target MS that the MS permits location by the indicated type of LCS client. The MSC then forwards the BSSMAP-LE PERFORM LOCATION request received in step 3 to the SMLC. ~~The message is transported inside an SCCP connection request.~~

7.6.5.2 Positioning Measurement Establishment Procedure

(5) Refer to step 11~~9~~ for an MT-LR~~in section 7.1~~.

7.6.5.3 Location Calculation and Release Procedure

(6) When a location estimate best satisfying the requested QoS has been obtained, the SMLC returns it to the BSC if the SMLC is BSS based.

(7) If the SMLC is NSS based, the BSC instead returns the location estimate to the MSC.

(8) In the case of a NSS based SMLC, the MSC forwards the BSSMAP PERFORM LOCATION response received in step 7 to the BSC.

(9) The BSC returns the MS location estimate to the requesting LCS client.

7.6.6 Mobile Originating Location Request (MO-LR)

The following procedure allows an MS to request either its own location, or location assistance data or broadcast assistance data message ciphering keys from the network. Location assistance data may be used subsequently by the MS to compute its own location throughout an extended interval using a mobile based position method. Location assistance data may includThe a ciphering key enablesing the MS to decipher other location assistance data broadcast periodically by the network. The MO-LR after location update request may be used to request ciphering keys or GPS assistance data using the follow-on procedure described in GSM 04.08. The procedure may also be used to enable an MS to request that its own location be sent to another LCS client.

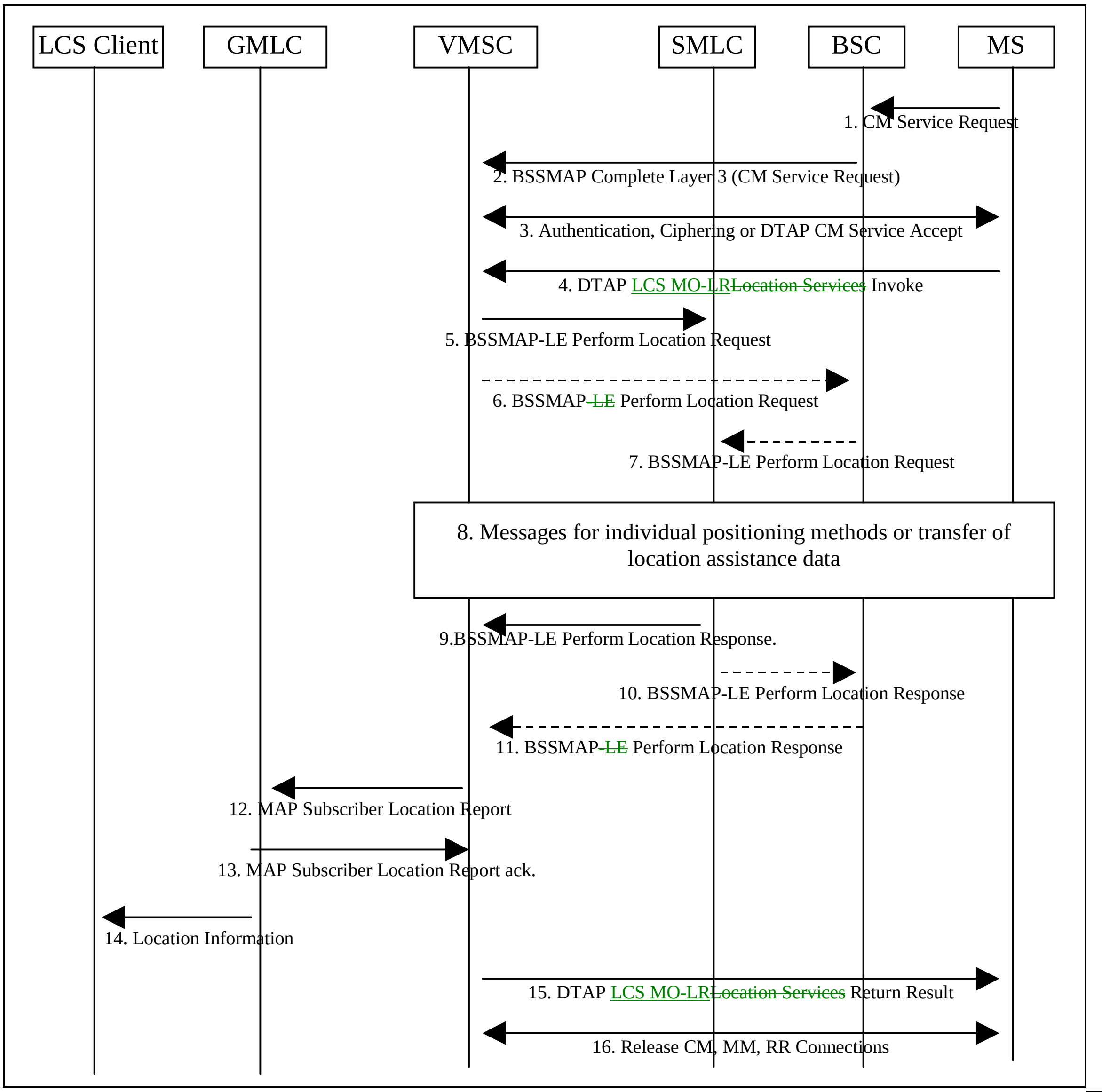


Figure 25 General Network Positioning for MO-LR

7.6.6.1 Location Preparation Procedure

1. If the MS is in idle mode, the MS requests an SDCCH and sends a DTAP CM service request indicating a request for call independent supplementary services to the BSC.

2. The BSC includes the current cell ID and TA value within the BSSMAP Complete Layer 3 Information message used to convey the CM service request across the A-interface. If the MS is instead in dedicated mode, the MS sends a DTAP CM Service Request on the already established SACCH: the VMSC will then already have been supplied with the current cell ID from either the serving BSC or serving MSC in the case of an established call with MSC-MSC handover.
3. The VMSC instigates authentication and ciphering if the MS was in idle mode or returns a DTAP CM Service Accept if the MS was in dedicated mode.
4. The MS sends a DTAP LCS MO-LR~~Location Services~~ invoke to the VMSC. If the MS is requesting its own location or that its own location be sent to another LCS client, this message carries LCS QoS information (e.g. accuracy, response time)~~ and may include measurement information to assist or enable computation of a location estimate~~. If the MS is requesting that its location be sent to another LCS client, the message shall include the identity of the LCS client and may include the address of the GMLC through which the LCS client should be accessed. If a GMLC address is not included, the VMSC may assign its own GMLC address and may verify that the identified LCS client is supported by this GMLC. If a GMLC address is not available for this case, the VMSC shall reject the location request. If the MS is instead requesting location assistance data or ciphering keys, the message specifies the type of assistance data or deciphering keys and the positioning method for which the assistance data or deciphering applies. The VMSC verifies in the MS's subscription profile that the MS has permission to request its own location, request that its location be sent to another LCS client or request location assistance data or deciphering keys (whichever applies). If the MS is requesting positioning and has an established call, the VMSC may reject the request for certain non-speech call types.
5. The VMSC sends a BSSMAP-LE PERFORM LOCATION request message to the SMLC associated with the MS's current cell location if the SMLC is NSS based. This message is transported using SCCP connection oriented signaling inside an SCCP Connection Request message The BSSMAP-LE message indicates whether a location estimate or location assistance data is requested and includes the MS's location capabilities and current cell ID. If the MS's location is requested, the message also includes the currently assigned radio channel type (SDCCH, TCH-FR or TCH-HR), the requested QoS and, if available~~,~~ and any location measurement information including the TA value received from the BSC in step 2~~ and from the target MS in step 4~~. If location assistance data is instead requested, the message carries the requested types of location assistance data.
6. If the SMLC is BSS based, the VMSC instead sends the BSSMAP~~-LE~~ PERFORM LOCATION message to the serving BSC for the target MS.
7. In the case of a BSS based SMLC, the BSC forwards the BSSMAP-LE PERFORM LOCATION request received in step 6 to the SMLC. If the MS's location is requested, the BSC may add additional measurement data to the message to assist with positioning. The message is transported inside an SCCP connection request.

7.6.6.2 Positioning Measurement Establishment Procedure

8. If the MS is requesting its own location, the actions described under step 10 for a MT-LR are performed. If the MS is instead requesting location assistance data, the SMLC transfers this data to the MS as described in subsequent sections. The SMLC determines the exact location assistance data to transfer according to the type of data specified by the MS, the MS location capabilities and the current cell ID.

7.6.6.3 Location Calculation and Release Procedure

9. When a location estimate best satisfying the requested QoS has been obtained or when the requested location assistance data has been transferred to the MS, the SMLC returns a BSSMAP-LE Perform Location response to the VMSC if the SMLC is NSS based. This message carries the location estimate or ciphering keys if this was obtained~~ or indicates the type of location assistance data transferred to the MS~~. If a location estimate or deciphering keys were not successfully obtained or if the requested location assistance data could not be transferred successfully to the MS, a failure cause is included in the Perform Location response.
10. For a BSS based SMLC, the BSSMAP-LE Perform Location response is instead returned to the serving BSC.
11. In the case of a BSS based SMLC, the BSC forwards the BSSMAP PERFORM LOCATION response received in step 10 to the VMSC.
12. If the MS requested transfer of its location to another LCS client and a location estimate was successfully obtained, the VMSC shall send a MAP Subscriber Location Report to the GMLC obtained in step 4 carrying the MSISDN of the MS, the identity of the LCS client, the event causing the location estimate (MO-LR) and the location estimate and its age.
13. The GMLC shall acknowledge receipt of the location estimate provided that is serves the identified LCS client and the client is accessible.
14. The GMLC transfers the location information to the LCS client either immediately or upon request from the client.
15. The VMSC returns a DTAP LCS MO-LR~~Location Services~~ Return Result to the MS carrying any location estimate requested by the MS, ciphering keys or a confirmation that a location estimate was successfully transferred to the GMLC serving an LCS client.

16. The VMSC may release the CM, MM and RR connections to the MS, if the MS was previously idle, and the VMSC may record billing information.

~~**Editorial Note:** need to add the MO-LR event to the MAP Subscriber Location Report in 09.02.~~

7.7 Common Procedures to Support Positioning

The procedures described in this section enable an SMLC to obtain positioning related information or instigate positioning for a particular target MS. The procedures are applicable to all positioning methods after an SMLC receives a BSSMAP-LE Perform Location request for a target MS until a BSSMAP-LE Perform Location response is returned to the originator.

~~7.7.1.~~7.7.1 Information Transfer between an NSS based SMLC and a Target MS

An NSS based SMLC uses the procedure shown in Figure 33 in order to obtain positioning information from a target MS after a positioning request has been received from the VMSC.

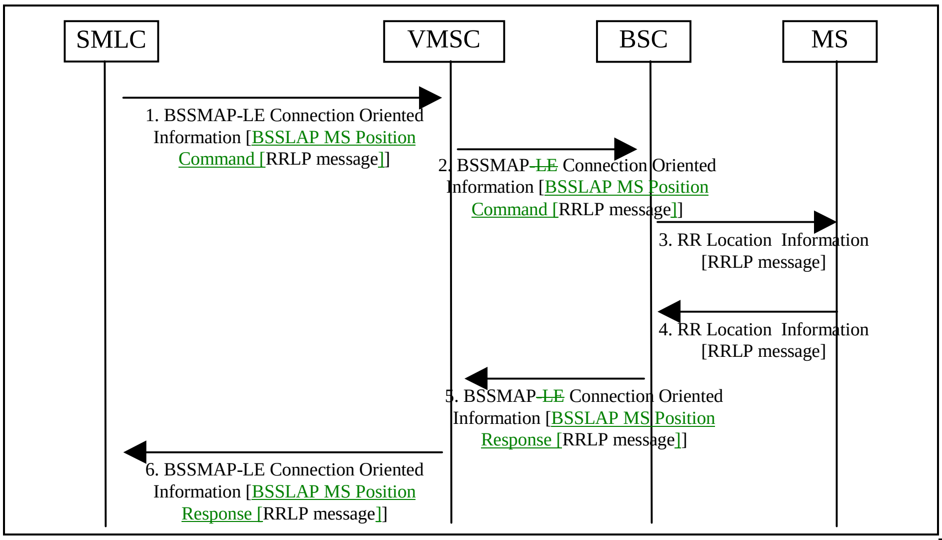


Figure 33 - Information Transfer between an NSS based SMLC and a Target MS

1. The SMLC passes a BSSMAP-LE Connection Oriented Information message to the VMSC containing an embedded BSSLAP MS Position Command with an RRLP message parameter. The message is transferred using the SCCP connection established between the SMLC and VMSC for positioning the target MS. If an RRLP message is too large to fit in a single BSSMAP-LE Connection Oriented Information message, it may be segmented and transferred inside a sequence of BSSMAP-LE messages with the last BSSMAP-LE message containing a BSSLAP MS Position command containing a last segment indication and the last RRLP segment. The SMLC shall indicate in the first BSSLAP MS Position Command whether the RRLP message contains a positioning command. versus positioning assistance data.
2. The VMSC forwards the BSSMAP message(s) to the serving BSC for the target MS.
3. The BSC transfers the embedded RRLP message to the target MS inside an RR LCS Information message. If the RRLP message was segmented by the SMLC, each RRLP segment is transferred in a separate RR LCS Information message with the last message indicating the last RRLP segment. When the last RR LCS Information message has been transferred, the BSC starts or restarts a positioning supervision timer if none is already in progress or if an RRLP positioning command was indicated. If the timer expires before the final response in step 4 is received, the BSC shall return a BSSMAP-LE Connection oriented Information message to the SMLC containing a BSSLAP Abort with a cause of BSC timeout.
4. When the target MS has positioning information to return to the SMLC, it sends an RR LCS Information message to the BSC containing an embedded RRLP message. If the RRLP message is too large to fit in a single RR LCS Information message, it may be segmented and carried in a sequence of RR LCS Information messages with the last message indicating the last RRLP segment. The first RR LCS Information message shall indicate if this is the final response from the MS.

5. If the timer started in step 3 has already expired, the BSC discards the RRLP message received in step 4. Otherwise, the BSC forwards the RRLP message to the VMSC inside a BSSLAP MS Positioning Response message contained in a BSSMAP Connection Oriented Information message. If the RRLP message was segmented, each segment is transferred in a separate BSSMAP message with the last message carrying a BSSLAP MS Positioning Response indicating and containing the last RRLP segment. If the SMLC indicated a positioning command in step 1 and the MS has indicated a final response, the BSC may add additional measurement information to the BSSLAP MS Position Response in the last BSSMAP-LE message – if necessary, creating a new BSSMAP message if message size limitations would be exceeded. The BSC shall stop the supervision timer started in step 3 when the final segment of the final response from the MS has been transferred.
6. The VMSC forwards the BSSMAP-LE message(s) to the SMLC using the SCCP connection previously established for positioning the target MS. If the MS did not indicate a final response in step 3, the SMLC may transfer a further RRLP message to the MS (e.g. containing assistance data) according to steps 1 to 3 and the MS may return a subsequent response according to steps 4 to 6.

~~7.7.2.~~7.7.2 Information Transfer between a BSS based SMLC and a Target MS

A BSS based SMLC uses the procedure shown in Figure 34 in order to obtain positioning measurements from a target MS after a positioning request has been received from the BSC serving the target MS.

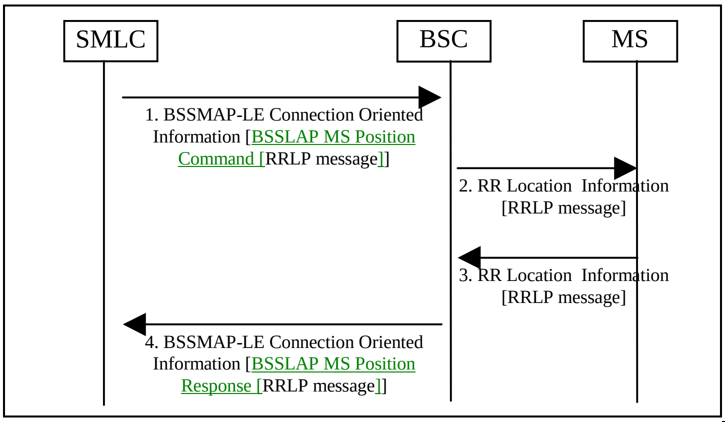


Figure 34 - Information Transfer between a BSS based SMLC and a Target MS

1. The SMLC passes a BSSMAP-LE Connection Oriented Information message to the serving BSC containing an embedded BSSLAP MS Position Command with an RRLP message parameter. The message is transferred using the SCCP connection established between the SMLC and BSC for positioning the target MS If an RRLP message is too large to fit in a single BSSLAP-LE Connection Oriented Information message, it may be segmented and transferred inside a sequence of BSSLAP-LE messages with the last BSSLAP-LE message containing a BSSLAP MS Position command containing a last segment indication and the last RRLP segment. The SMLC shall indicate in the first BSSLAP MS Position Command whether the RRLP message contains a positioning command. versus positioning assistance data.
2. The BSC transfers the embedded RRLP message to the target MS inside an RR LCS Information message. If the RRLP message was segmented by the SMLC, each RRLP segment is transferred in a separate RR LCS Information message with the last message indicating the last RRLP segment. When the last RR LCS Information message has been transferred, the BSC starts or restarts a positioning supervision timer if none is already in progress or if an RRLP positioning command was indicated. If the timer expires before the final response in step 3 is received, the BSC shall return a BSSMAP-LE Connection oriented Information message to the SMLC containing a BSSLAP Abort with a cause of BSC timeout.
3. When the target MS has positioning information to return to the SMLC, it sends an RR LCS Information message to the BSC containing an embedded RRLP message. If the RRLP message is too large to fit in a single RR LCS Information message, it may be segmented and carried in a sequence of RR LCS Information messages with the last message indicating the last RRLP segment. The first RR LCS Information message shall indicate if this is the final response from the MS.

4. If the timer started in step 2 has already expired, the BSC discards the RRLP message received in step 3. Otherwise, the BSC forwards the RRLP message to the SMLC inside a BSSLAP MS Positioning Response message contained in a BSSMAP-LE Connection Oriented Information message. If the RRLP message was segmented, each segment is transferred in a separate BSSMAP-LE message with the last message carrying a BSSLAP MS Positioning Response indicating and containing the last RRLP segment. If the SMLC indicated a positioning command in step 1 and the MS has indicated a final response, the BSC may add additional measurement information to the BSSLAP MS Position Response in the last BSSMAP-LE message – if necessary, creating a new BSSMAP-LE message if message size limitations would be exceeded. The BSC shall stop the supervision timer started in step 2 when the final segment of the final response from the MS has been transferred. If the MS did not indicate a final response in step 2, the SMLC may transfer a further RRLP message to the MS (e.g. containing assistance data) according to steps 1 and 2 and the MS may return a subsequent response according to steps 3 and 4,

4.

7.7.3. 7.7.3 Information Transfer between an NSS based SMLC and a BSC

An NSS based SMLC uses the procedure shown in Figure 35 in order to obtain positioning related information for a particular target MS from the BSC after a positioning request has been received from the VMSC.

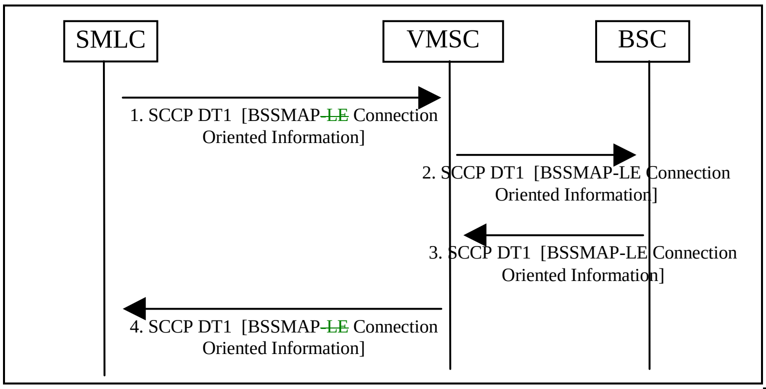


Figure 35 - Information Transfer between an NSS based SMLC and a BSC

1. The SMLC passes a BSSMAP Connection Oriented Information message to the VMSC containing an embedded BSSLAP message. The BSSMAP message is transferred using the SCCP connection previously established between the SMLC and MSC when the positioning request for the target MS was initially sent to the SMLC.
2. The VMSC forwards the BSSMAP-LE message to the BSC serving the target MS. The BSC recognizes that it is the final destination due to the presence of the embedded BSSLAP message.
3. When the BSC has positioning information for the target MS to return to the SMLC, it sends a BSSMAP-LE Connection Oriented Information message to the VMSC containing an embedded BSSLAP message..
4. The VMSC forwards the BSSMAP message to the SMLC using the SCCP connection previously established for positioning the target MS.

7.7.4. 7.7.4 Information Transfer between a BSS based SMLC and a BSC

A BSS based SMLC uses the procedure shown in Figure 36 in order to obtain positioning related information from the BSC serving a particular target MS after a positioning request has been received from the BSC.

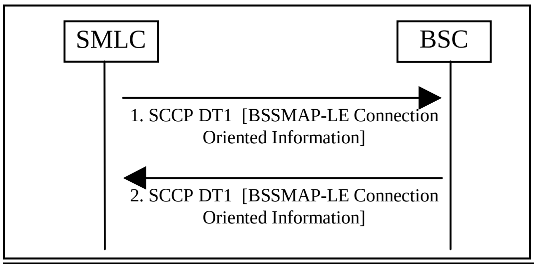


Figure 36 - Information Transfer between a BSS based SMLC and a BSC

1. The SMLC passes a BSSMAP-LE Connection Oriented Information message to the BSC containing an embedded BSSLAP message. The BSSMAP-LE message is transferred using the SCCP connection previously established between the SMLC and BSC when the positioning request for the target MS was initially sent to the SMLC. The BSC recognizes that it is the final destination due to the presence of the embedded BSSLAP message.
2. When the BSC has positioning information for the target MS to return to the SMLC, it sends a BSSMAP-LE Connection Oriented Information message to the SMLC containing an embedded BSSLAP message. The message is sent using the SCCP connection previously established for positioning the target MS.

7.8 Common Procedures to Support Access to an LMU

The procedures in this section support the transfer of positioning related information and O&M data between an SMLC and a particular LMU associated with the SMLC.

7.8.1 Information Transfer between an NSS based SMLC and a Type A LMU

7.8.1.1 Information Transfer using an SDCCH

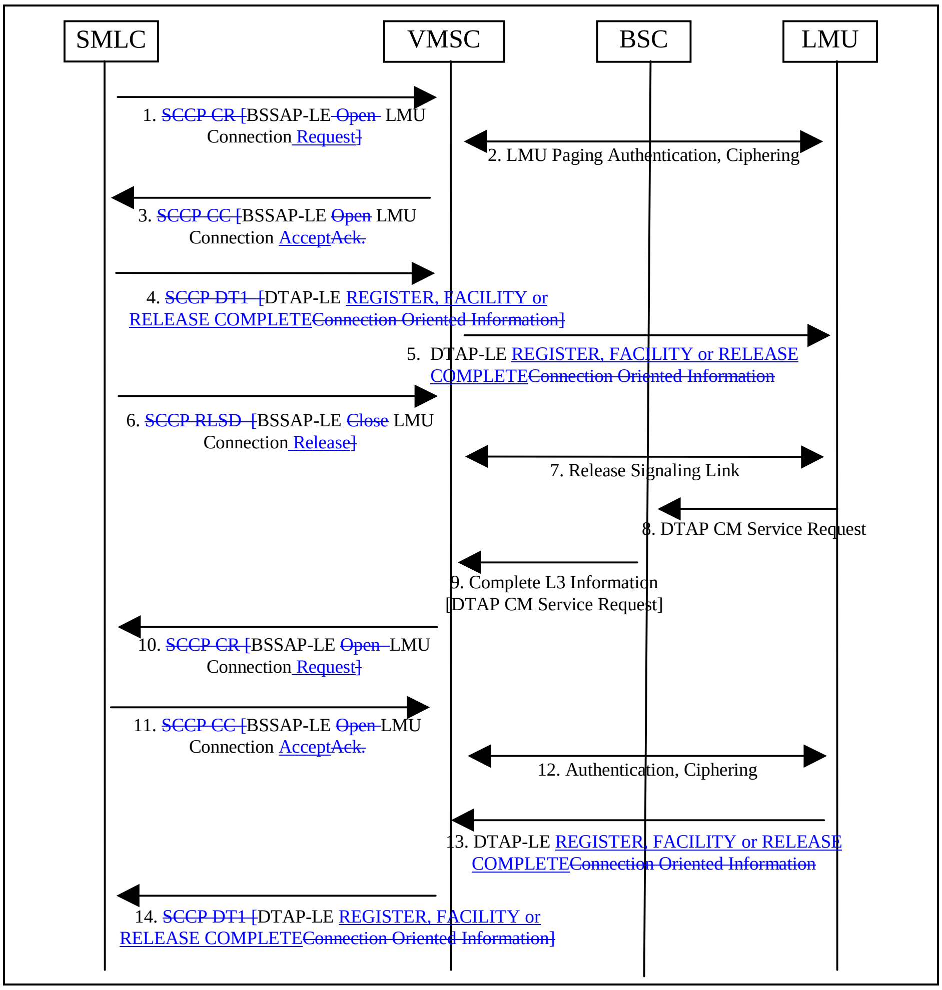


Figure 26 Information Transfer between an NSS based SMLC and a Type A LMU using an SDCCH

1. If there is no SCCP connection yet for an LMU between the SMLC and the MSC serving the LMU, the SMLC sends a BSSMAP-LE Open LMU connection request message to the MSC contained in an SCCP Connection Request. The BSSMAP-LE message shall contain the IMSI of the LMU and shall indicate whether authentication of the LMU is needed and/or ciphering.
2. For an LMU that has no main signaling link to the MSC (e.g. LMU uses a temporary SDCCH), the serving MSC performs paging to assign an SDCCH. The MSC/VLR also performs authentication and/or ciphering if requested by the SMLC.
3. The serving MSC returns a BSSMAP-LE LMU Open Connection Acceptack. inside an SCCP connection confirm to the SMLC. If the paging or authentication in step 2 failed, the MSC returns an BSSMAP-LE LMU Connection Reject messageSCCP connection refused message.
4. If the SMLC needs to send data to the LMU, it may send one or more DTAP-LE REGISTER, FACILITY and RELEASE COMPLETE messages to the serving MSC using the SCCP connection established in steps 1 to 3inside SCCP data form 1 messages. Each DTAP-LE message may carry and embedded LLP message or message segment and an indication of whether release of the SDCCH by the LMU is forbidden.
5. The serving MSC passes each DTAP-LE message received from the SMLC in step 4 to the LMU.
6. The SMLC may initiate release of the SDCCH to the LMU and the associated SCCP connection to the MSC by sending a BSSMAP-LE Close LMU Connection Release message inside an SCCP Released message.
7. For an LMU that has no other active MM and CM connections, the MSC initiates release of the SDCCH.
8. When the LMU has LCS data to send and does not currently have a signaling link, it sends an RR Channel request to the serving BTS to request an SDCCH. The RR Channel Request contains an establishment cause identifying an LMU. After assignment of the SDCCH, the LMU sends a DTAP CM Service request to the serving BSC to request an MM connection for location services.

9. The serving BSC passes the CM Service Request to the VMSC with an indication that this came from an LMU inside a Complete layer 3 Information message.
10. The serving MSC sends a BSSMAP-LE ~~Open~~ LMU Connection Request message to the SMLC associated with the LMU inside an SCCP connection request (e.g. use IMSI or LAC association to determine the SMLC). The BSSMAP-LE message shall contain the IMSI of the LMU and the address of the MSC.
11. The SMLC returns a BSSMAP-LE ~~Open~~ LMU Connection Accept~~ack~~. to the MSC ~~inside an SCCP connection confirm~~ indicating if authentication or ciphering are required.
12. The serving MSC performs authentication and ciphering if requested by the SMLC. Otherwise, a CM Service Accept is returned.
13. The LMU sends one or more DTAP-LE REGISTER, FACILITY and RELEASE COMPLETE messages to the serving MSC each containing an embedded LLP message or message segment.
14. The serving MSC passes each DTAP-LE message to the SMLC using the SCCP connection established in steps 10 to 11~~inside an SCCP data form 1 message~~

7.8.1.2 Information Transfer using a TCH

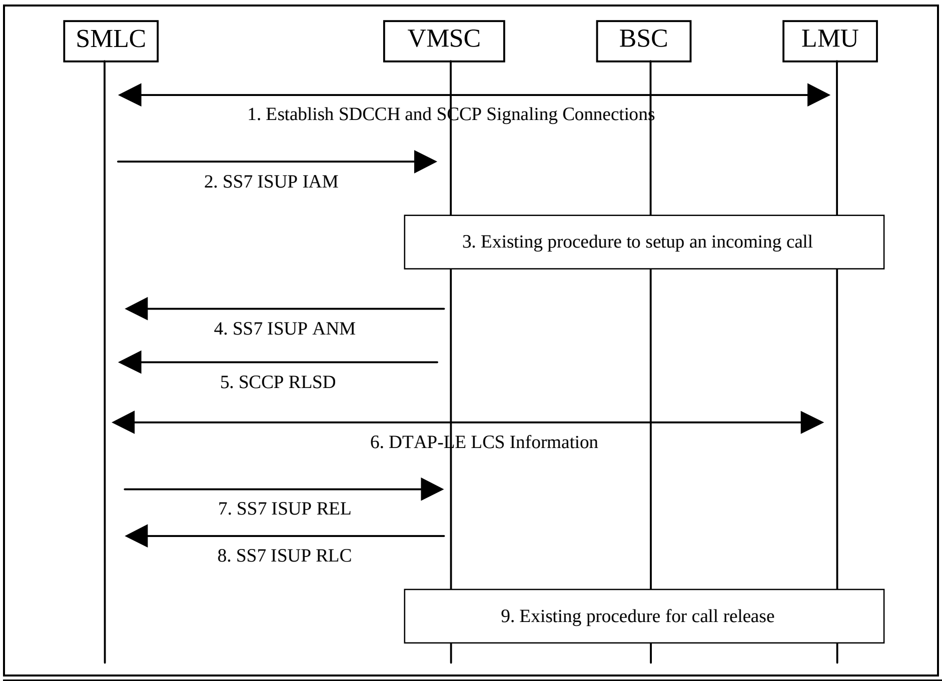


Figure 27 Information Transfer between an NSS based SMLC and a Type A LMU using a TCH

1. The SMLC or LMU establishes a signaling connection to the other entity~~LMU~~ using an SDCCH. The ~~V~~VMSC provides the SMLC with a~~n~~ called number~~MSRN~~ identifying the LMU in the BSSMAP-LE ~~Open~~ LMU Connection Request or Accept~~Ack.~~
2. The SMLC sends an ISUP IAM to the VMSC with the called number~~MSRN~~ from step 1 in the called party number. The IAM contains the required bearer capability and references a 64 Kbps trunk connection between the SMLC and~~to~~ the ~~V~~VMSC. The ~~V~~VMSC may verify that the SMLC is the source of the IAM from the SS7 link on which the IAM is received (with dedicated links on the Ls interface), the SS7 OPC in the MTP routing label or the referenced trunk connection.
3. The ~~V~~VMSC establishes an incoming call to the LMU with the requested bearer capability using the existing procedure defined in GSM 04.08. For this procedure,~~ use of~~ an ALERTING message from the LMU shall not be used~~is unnecessary~~.
4. The ~~V~~VMSC confirms the call establishment to the SMLC – the TCH is through connected to the 64 Kbps trunk indicated in step 2.
5. The ~~V~~VMSC initiates release of the SCCP connection to the SMLC established in step 1 by sending an SCCP Released message.

6. DTAP-LE REGISTER, FACILITY and RELEASE COMPLETE messages are transferred between the SMLC and LMU on the established TCH: these are transparent to the VMSC and BSC.
7. The SMLC initiates release of the TCH by sending an ISUP REL to the VVMSC.
8. The SMLC acknowledges the release request.
9. The VMSC releases the call and the TCH to the LMU using the existing procedure defined in GSM 04.08.

Information Transfer between a BSS based SMLC and a Type A LMU with NSS Assistance

Information Transfer using an SDCCH

The following procedure supports a BSS based SMLC with the same impacts in the MSC/VLR, SMLC and LMU as for an NSS based SMLC. This simplifies migration from an NSS based SMLC to a BSS based SMLC and provides an intermediate migration point towards an unassisted BSS based SMLC.

Note that all DTAP messages received by the BSC from the LMU that carry the LCS PD are transferred by the BSC to the SMLC using SCCP connection oriented signaling. All DTAP messages carrying any other PD are transferred by the BSC to the MSC.

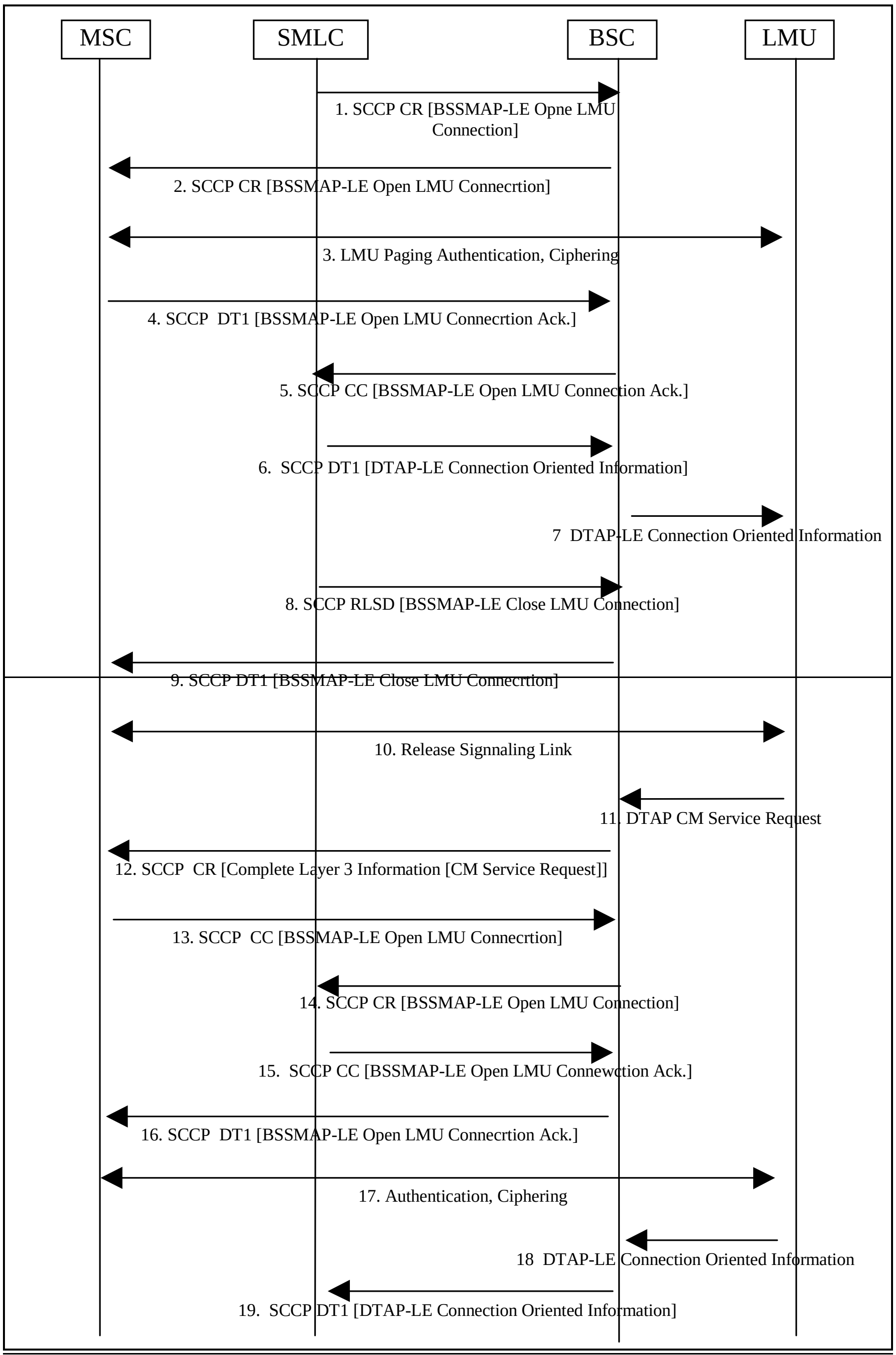


Figure 28 Information Transfer between a BSS based SMLC and a Type A LMU with NSS Assistance

If there is no SCCP connection yet for a type A LMU between the SMLC and the BSC serving the LMU, the SMLC sends a BSSMAP-LE Open LMU connection message to the BSC contained in an SCCP Connection Request. The BSSMAP-LE message shall contain the IMSI of the LMU, the type of the LMU and shall indicate whether authentication of the LMU is needed and/or ciphering.

If there is no main signaling link to the LMU (e.g. LMU uses a temporary SDCCH), the serving BSC passes the BSSMAP-LE message to the serving MSC.

The serving MSC performs paging to assign an SDCCH. The MSC/VLR also performs authentication and/or ciphering if requested by the SMLC.

The serving MSC returns a BSSMAP-LE LMU Open Connection ack. to the serving BSC.

The serving BSC passes the BSSMAP-LE message to the SMLC inside an SCCP connection confirm.

If the SMLC needs to send data to the LMU, it may send one or more DTAP-LE REGISTER, FACILITY or RELEASE COMPLETE messages to the serving BSC.
The serving BSC transfers each DTAP-LE message transparently to the LMU.
The SMLC may initiate release of the SDCCH to the LMU by sending a BSSMAP-LE Close LMU Connection message.
The serving BSC passes the BSSMAP-LE message to the serving MSC.
For a type A LMU that has no other active MM and CM connections, the MSC initiates release of the SDCCH.
When the LMU has LCS data to send and does not currently have a signaling link, it sends an RR Channel Request to the serving BTS to request an SDCCH. The RR Channel Request contains an establishment cause identifying an LMU. After assignment of the SDCCH, the LMU sends a DTAP CM Service request to the serving BSC to request an MM connection for location services.
Because the CM Service Request carries an MM protocol discriminator, the BSC transfers the CM Service request with an indication that this came from an LMU to the MSC in a BSSMAP Complete Layer 3 Information message that is inside an SCCP Connection Request.
The serving MSC sends a BSSMAP-LE Open LMU Connection message to the serving BSC inside an SCCP Connection Confirm. The BSSMAP-LE message shall contain the IMSI of the LMU and the assumed type of the LMU.
The serving BSC passes the message to the SMLC inside an SCCP connection request.
The SMLC returns a BSSMAP-LE Open LMU Connection ack. to the BSC inside an SCCP connection confirm indicating if authentication or ciphering are required.
The serving BSC passes this message to the MSC.
The serving MSC performs authentication and ciphering if requested by the SMLC.
The LMU sends one or more DTAP-LE REGISTER, FACILITY or RELEASE COMPLETE messages to the serving BSC each containing an embedded LLP message.
19.Because there is now an SCCP connection to the SMLC, the serving BSC passes each DTAP-LE message to the SMLC.

Information Transfer Using a TCH

The SMLC may assign a TCH to an LMU using nearly the same procedure as for an NSS based SMLC. The only difference is that once the TCH is assigned, the BSC rather than MSC would release the SCCP connection previously established between the BSC and SMLC.

7.8.2 Location Update Procedure between a BSS based SMLC and a Type A LMU without NSS Assistance

The following procedure supports a normal GSM location update from the perspective of a type A LMU. The location update can occur periodically, on power up, following recovery from some failure condition and when an LMU in idle mode detects that its closest BTS is in another location area. A subscription of the LMU in an HLR is not needed if this procedure is supported by the SMLC.

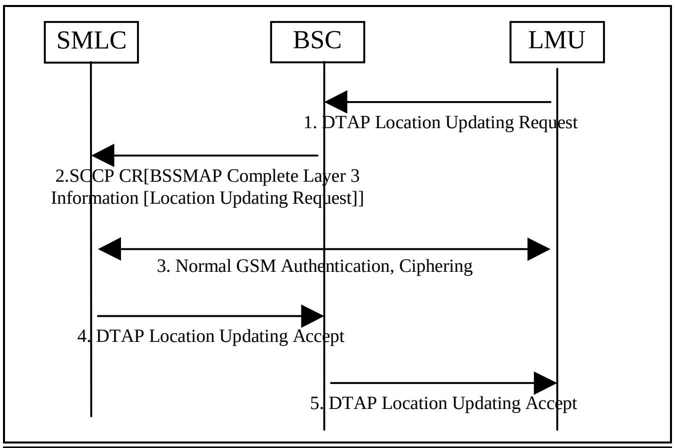


Figure 29 Location Update Procedure between a BSS based SMLC and a Type A LMU without NSS Assistance

1. If the LMU does not currently have a signaling link, it sends an RR Channel Request to the serving BTS to request an SDCCH. The RR Channel Request contains an establishment cause identifying an LMU. After assignment of the SDCCH, the LMU sends a DTAP Location Updating request to the BSC. This shall indicate that a follow on request is pending if the LMU has more data to send.
2. The BSC serving the LMU forwards the Location Updating request to the SMLC. If there was previously no SDCCH, this is sent inside a BSSMAP Complete Layer 3 Information message that is contained in an SCCP Connection Request.
3. The SMLC performs existing GSM authentication and ciphering if needed for the LMU.
4. The SMLC returns a DTAP Location Updating AcceptRequest to the BSC. Unless the LMU indicated a follow on request, the SMLC may then initiate release of the SDCCH.
5. The BSC forwards the DTAP message to the LMU.

7.8.3 IMSI Detach Procedure between a BSS based SMLC and a Type A LMU without NSS Assistance

The following procedure supports a normal GSM IMSI Detach from the perspective of a type A LMU. This may be instigated if the LMU is to be deactivated – e.g. for offline maintenance.

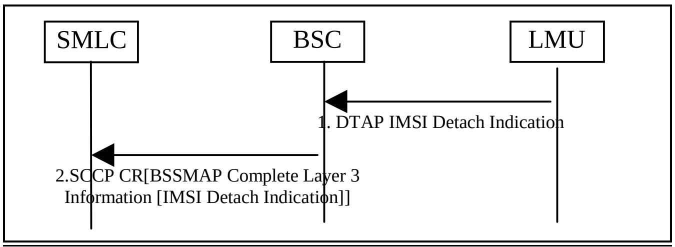


Figure 30 IMSI Detach Procedure between a BSS based SMLC and a Type A LMU without NSS Assistance

1. If the LMU does not currently have a signaling link, it sends an RR Channel Request to the serving BTS to request an SDCCH. The RR Channel Request contains an establishment cause identifying an LMU. After assignment of the SDCCH, the LMU sends a DTAP IMSI Detach Indication to the BSC.
2. The BSC serving the LMU forwards the IMSI Detach Indication to the SMLC. If there was previously no SDCCH, this is sent inside a BSSMAP Complete Layer 3 Information message that is contained in an SCCP Connection Request. The SMLC marks the LMU as temporarily inactive and initiates release of the SDCCH.

7.8.4 LCS Information Transfer between a BSS based SMLC and a Type A LMU without NSS Assistance

7.8.4.1 Information Transfer using an SDCCH

The following procedure supports information transfer between a BSS based SMLC and a type A LMU without assistance from the NSS.

In order to migrate from the NSS assisted to the unassisted mode for a BSS based SMLC, it would be useful to temporarily support both modes in the same BSC, with each LMU being assigned to a particular mode – e.g. according to the LMU's serving LAC/CI. This allows gradual migration of LMUs from NSS assisted to unassisted mode and enables testing of the unassisted mode on just a few LMUs prior to a complete migration.

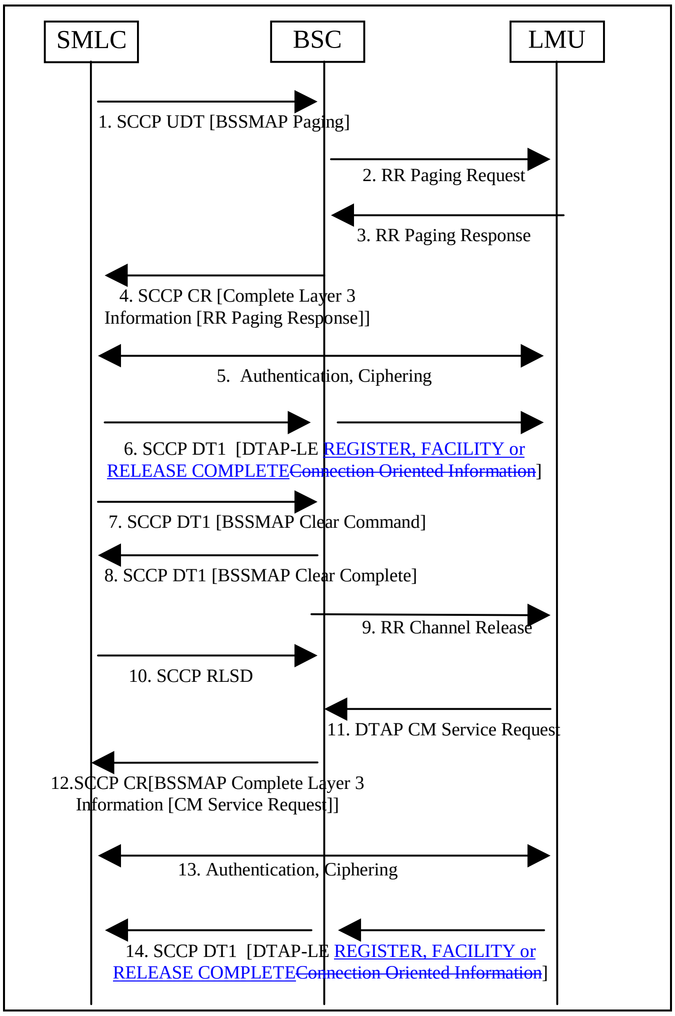


Figure 31 Information Transfer between a BSS based SMLC and a Type A LMU ~~without NSS Assistance~~

1. If there is no signaling link yet for an LMU between the SMLC and the BSC serving the LMU, the SMLC sends a BSSMAP Paging message to the serving BSC inside an SCCP Unitdata message.
2. The serving BSC broadcasts an RR Paging Request.
3. The LMU returns an RR Paging Response.
4. The serving BSC transfers the Paging Response to the SMLC in a BSSMAP Complete Layer 3 Information message contained in an SCCP Connection Request.
5. The SMLC performs normal GSM authentication and ciphering if this is needed for the LMU.
6. If the SMLC needs to send data to the LMU, it may send one or more DTAP-LE REGISTER, FACILITY or RELEASE COMPLETE messages to the BSC. Each DTAP-LE message contains an embedded LLP message or message segment and an indication of whether release of the SDCCH by the LMU is forbidden. Each DTAP-LE message is transferred by the BSC to the LMU.
7. The SMLC may initiate release of the SDCCH to the LMU by sending a BSSMAP Clear Command to the BSC.
8. The BSC returns a BSSMAP Clear Complete.
9. The BSC orders release of the SDCCH by sending an RR Channel Release to the LMU.
10. The SMLC releases the SCCP connection to the BSC by sending an SCCP Released message.
11. When the LMU has LCS data to send and does not currently have a signaling link, it sends an RR Channel Request to the serving BTS to request an SDCCH. The RR Channel Request contains an establishment cause identifying an LMU. After assignment of the SDCCH, the LMU sends a DTAP CM Service request to the serving BSC.
12. The serving BSC forwards the CM Service Request with an indication that this came from an LMU to the SMLC inside a BSSMAP Complete Layer 3 Information message that is contained in an SCCP Connection Request.
13. The SMLC performs authentication and ciphering if needed for the LMU. Otherwise, a CM Service Accept is returned.

14. The LMU sends one or more DTAP-LE REGISTER, FACILITY or RELEASE COMPLETE messages to the serving BSC each containing an embedded LLP message or message segment. The BSC forwards each DTAP-LE message to the SMLC.

7.8.4.2 Information Transfer using a TCH

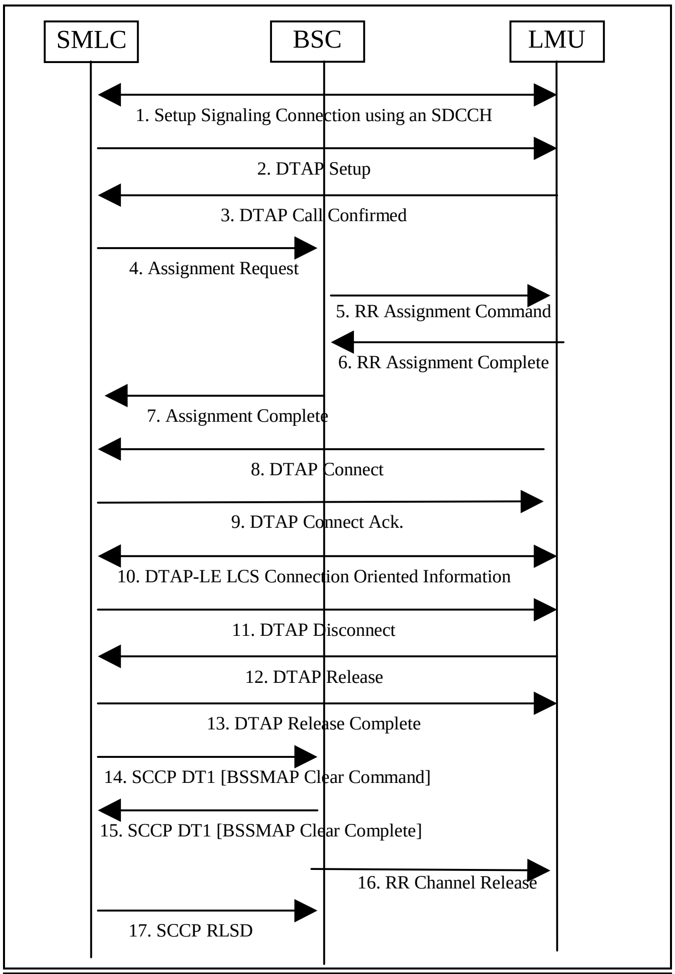


Figure 32 Information Transfer between a BSS based SMLC and a Type A LMU using a TCH

1. The SMLC establishes a signaling connection to the LMU using an SDCCH.
2. The SMLC sends a DTAP Setup to the LMU with the requested bearer capability.
3. The LMU returns a DTAP Call Confirmed.
4. The SMLC initiates traffic channel assignment by sending a BSSMAP Assignment Request to the BSC.
5. The BSC requests channel activation in the BTS and then sends an RR Assignment Command to the LMU.
6. The LMU acknowledges TCH assignment.
7. The BSC confirms TCH assignment.
8. The LMU confirms call establishment.
9. The SMLC acknowledges the LMU confirm.
10. DTAP-LE Connection Oriented Information messages are transferred between the SMLC and LMU on the established TCH: these are transparent to the BSC.
11. The SMLC initiates release of the TCH by sending a DTAP Disconnect to the LMU
12. The LMU returns a DTAP Release.
13. The SMLC~~VMSC~~ sends a DTAP Release Complete.
14. The SMLC initiates release of the TCH by sending a BSSMAP Clear Command to the BSC.
15. The BSC returns a BSSMAP Clear Complete.
16. The BSC orders release of the TCH by sending an RR Channel Release to the LMU.

17. The SMLC releases the SCCP connection to the BSC by sending an SCCP Released message.

7.8.5 Information Transfer between an NSS based SMLC and a Type B LMU

An NSS based SMLC uses the procedure shown in Figure 37 in order to exchange LCS information with a type B LMU.

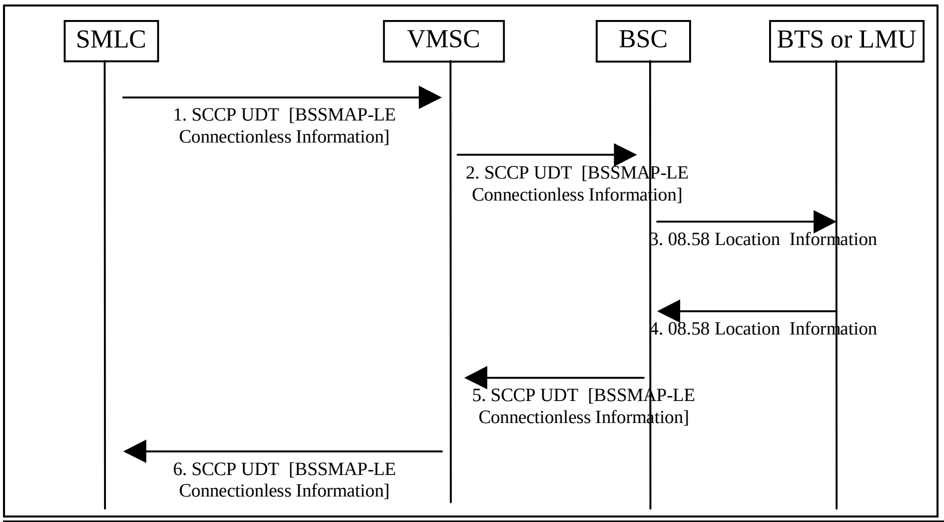


Figure 37 - Information Transfer between an NSS based SMLC and a Type B LMU

1. The SMLC passes a BSSMAP-LE Connectionless Information message to the VMSC containing an embedded LLP message and the LAC/CI cell address identifying the LMU. The BSSMAP-LE message is transferred inside an SCCP Unitdata message.
2. The VMSC forwards the BSSMAP-LE message to the BSC serving the LAC/CI address.
3. The BSC transfers the embedded RRLP message to either the BTS associated with the LMU or the LMU itself inside an 08.58 LCS Information message. The BTS or LMU is identified using the LAC/CI received in step 2.
4. When the LMU has positioning information to return to the SMLC, either it or its associated BTS transfers this to the BSC inside an 08.58 LCS Information message.
5. The serving BSC forwards the RRLP message to the VMSC inside a BSSMAP-LE Connectionless Information message contained in an SCCP Unitdata message. The BSSMAP-LE message contains the LAC/CI address identifying the LMU.
6. The VMSC forwards the BSSMAP-LE message to the SMLC in an SCCP Unitdata message.

7.8.6 Information Transfer between a BSS based SMLC and a Type B LMU

A BSS based SMLC uses the procedure shown in Figure 38 in order to exchange LCS information with a type B LMU.

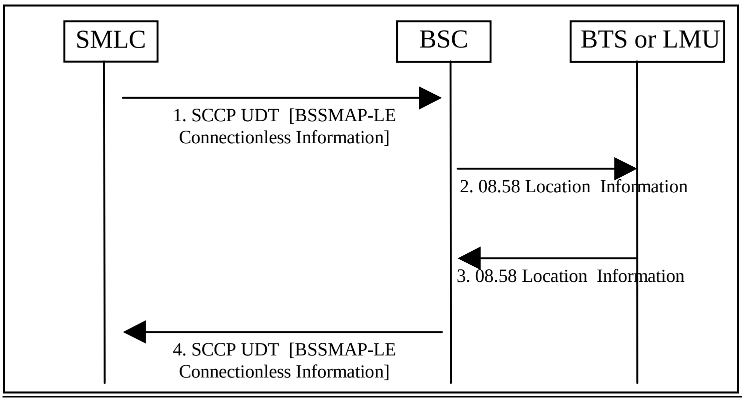


Figure 38 - Information Transfer between a BSS based SMLC and a Type B LMU

1. The SMLC passes a BSSMAP-LE Connectionless Information message to the BSC containing an embedded LLP message and the LAC/CI cell address identifying the LMU. The BSSMAP-LE message is transferred inside an SCCP Unitdata message.
2. The BSC transfers the embedded LLP message to either the BTS associated with the LMU or the LMU itself inside an 08.58 LCS Information message. The BTS or LMU is identified using the LAC/CI received in step 1.
3. When the LMU has positioning information to return to the SMLC, either it or its associated BTS transfers this to the BSC inside an 08.58 LCS Information message.
4. The serving BSC forwards the LLP message to the SMLC inside a BSSMAP-LE Connectionless Information message contained in an SCCP Unitdata message. The BSSMAP-LE message contains the LAC/CI address identifying the LMU.

7.9 Common Control Procedures for LMUs

The procedures in this section are applicable to any Type A LMU and may be used for any Type B LMU to enable control of the LM by its associated SMLC. The procedures assume support for the establishment of a signaling link and the transfer of LLP messages between an SMLC and LMU that are defined in section 7.8. Consequently, details of signaling link establishment and message transfer by an intermediate MSC, BSC and BTS are not shown.

~~7.9.1.~~7.9.1 Reset Procedure

The reset procedure enables an SMLC to return an LMU to a known initial state in which no measurement or O&M operations are outstanding or being performed.

Editorial Note: a Reset return result and Return Error should be added to 04.71.

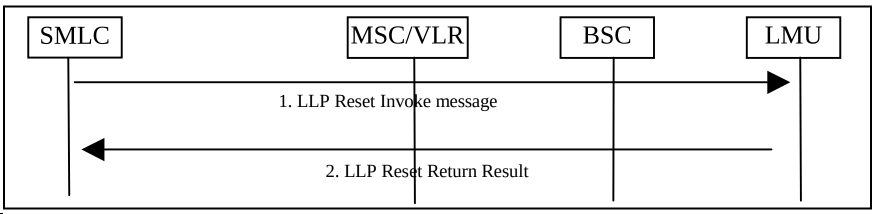


Figure 41~~17~~12 Reset Procedure for a Circuit Mode LMU

(1) After first establishing a signaling connection to the LMU (see section 7.8), the SMLC sends an LLP Reset Invoke to the LMU via an intermediate MSC and/or BSC.

(2) The LMU cancels any LCS measurement and O&M tasks previously ordered by the SMLC. The LMU then returns an LLP Reset Return Result to the SMLC.

~~7.9.2.~~7.9.2 Status Query Procedure

The Status Query procedure enables an SMLC to verify the status of an associated LMU. The procedure may be instigated periodically or following any loss of communication with the LMU.

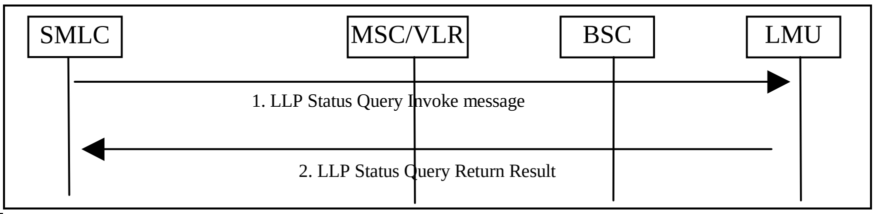


Figure 43~~18~~13 Status Query Procedure for a Circuit Mode LMU

(1) After first establishing a signaling connection to the LMU (see section 7.8), the SMLC sends an LLP Status Query Invoke to the LMU via an intermediate MSC and/or BSC.
(2) The LMU returns an LLP Status Query return result, indicating the number of active measurement jobs for each type of measurement (e.g. RIT, TOA) and the number of active O&M jobs in the LMU that were previously ordered by the SMLC.

~~7.9.3.~~7.9.3 Status Update Procedure

The Status Update procedure enables an LMU to report status information to its associated SMLC. For a Type A LMU with an associated NSS based SMLC, instigation of the procedure also provides the SMLC with the identity of the MSC currently serving the LMU. The procedure may be instigated for the following reasons:

1. Periodically
2. Power-on condition or recovery from failure with loss of memory
3. Impending availability or unavailability for O&M reasons
4. Location Update by a Type A LMU in a new Location Area.

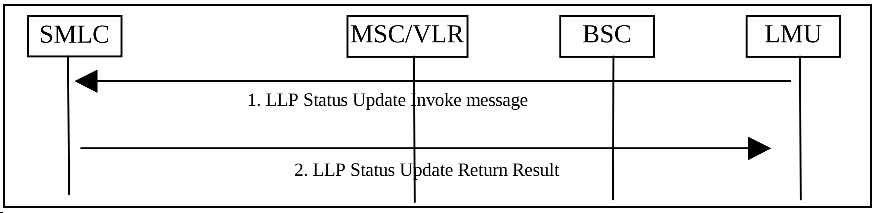


Figure 45~~19~~14 Status Update Procedure for a Circuit Mode LMU

(1) After first establishing a signaling connection to the SMLC (see section 7.8), the LMU sends an LLP Status Update Invoke to the SMLC via an intermediate MSC and/or BSC. This message shall include the reason for the Status Update, the number of active and outstanding jobs of each category in the LMU and the current hardware status.
(2) The SMLC returns an LLP Status Update return result to acknowledge receipt of the Status Update.

7.10 Common Procedures supporting Interaction between Peer SMLCs

7.10.1 Information Transfer between Peer SMLCs

Figure 39 illustrates LCS information transfer between peer SMLCs where, in this scenario, one SMLC is NSS based and the other BSS based. It is assumed that while the NSS based SMLC has SS7 links to an STP, the BSS based SMLC does not.

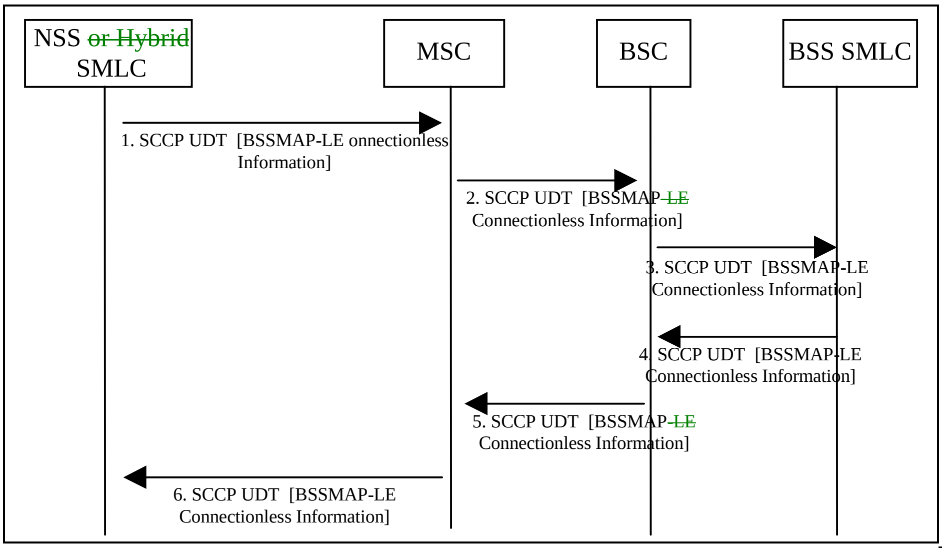


Figure 39 - Information Transfer between an NSS based and a BSS based SMLC

1. When the NSS based SMLC has LCS information to send to another SMLC, it transmits a BSSMAP-LE Connectionless Information message containing an embedded SMLCPP message and the LAC/CI cell address identifying the other SMLC. The BSSMAP-LE message is transferred inside an SCCP Unitdata message. The message is routed to an SS7 signaling point code associated with the LAC/CI address. In this scenario, the signaling point code is that for the MSC connected to the BSC for the BSS based SMLC.
2. The MSC forwards the BSSMAP-LE message to the BSC associated with the LAC/CI address received in step 1.
3. The BSC transfers the BSSMAP-LE message to the SMLC. The BSC recognizes the SMLC as the final destination due to the presence of the embedded SMLCPP message.
4. When the BSS based SMLC has positioning information to return to the NSS based SMLC, it passes this to its associated BSC in a BSSMAP-LE Connectionless message contained in an SCCP Unitdata message. The BSSMAP-LE message contains an embedded SMLCPP message and the LAC/CI address identifying the other SMLC.
5. The serving BSC forwards the BSSMAP-LE message to its MSC.
6. The MSC forwards the BSSMAP-LE message directly to the NSS based SMLC in an SCCP Unitdata message. The message is routed to an SS7 signaling point code associated with the LAC/CI address in the BSSMAP-LE message. In this scenario, the signaling point code is that for the NSS based SMLC.

6.5.7.11 Exception Procedures

6.5.1.7.11.1 Procedures in the SMLC

When a location attempt fails due to failure of a position method itself (e.g. due to inaccurate or insufficient position measurements and related data) and the SMLC is unable to instigate another positioning attempt (e.g. due to a requirement on response time), the SMLC may return a BSSMAP-LE Perform Location response containing a less accurate location estimate (e.g. based on serving cell and timing advance). If a less accurate estimate is not available or will not meet the accuracy requirement, the SMLC shall instead return a BSSMAP-LE Perform Location responseReturn Error message to the VMSC containing no location estimate and indicating the cause of failure.

When a location attempt is interrupted by some other unrecoverable error event inside the SMLC, the SMLC shall immediately terminate the location attempt and return a BSSMAP Perform Location ResponseUser Abort message to the VMSC containing the reason for the location attempt cancellation. In that case, any dialogue previously opened with an LMU or serving BSC for the purpose of instigating position measurements for the MS being located may also be aborted by the SMLC.

If the SMLC receives an BSSMAP-LE Perform Location Abort indication for a a positioning attempt from the VMSC (NSS based SMLC) or BSC (BSS based SNLC), it shall immediately terminate the location attempt and may abort any dialogues used for the location attempt that still exist with any LMUs. Although the SMLC cannot abort any location procedure instigated in the serving BSC (e.g. for TOA), the circumstances of the abort may still ensure cancellation of any such procedure (see section on BSC).

If the SMLC has instigated any network based positioning procedure in the serving BSC for the target MS (e.g. TOA) and receives an error indication from the serving BSC, it shall cancel the network positioning attempt and may abort any dialogues used for this positioning attempt that currently exist with any LMUs. The SMLC may then instigate another positioning method or return any location estimate already derived to the VMSC, or the SMLC may return a MAP Perform Location return error to the VMSC indicating failure of positioning. If the reason for the BSC error was commencement of a radio related handover for the target MS, the SMLC may instead wait for a MAP LCS Information Report from the VMSC containing an indication from the new serving BSC that the handover procedure is complete. This message will also provide the new serving cell ID if the handover to a new cell was successful and the new timing advance. The SMLC may then resume positioning of the target MS or (e.g. if the new serving cell belongs to a different SMLC), it may return a MAP Perform Location return error to the VMSC requesting restart of the location attempt.If the SMLC has instigated any positioning procedure in the Target MS or its serving BSC and receives a BSSLAP Reject, BSSLAP Abort or BSSLAP Reset indication from the BSC, it shall cancel the positioning attempt and may abort any dialogues for this that currently exist with any LMUs. For a BSSLAP Abort, the SMLC shall then either return any location estimate already derived, if sufficient for the requested QoS, or return a BSSMAP-LE Perform Location response indicating failure of positioning and the cause of the failure in the BSSLAP Abort. For a BSSLAP Reject and BSSLAP Reset, the SMLC has the additional option of restarting the positioning attempt using the same or a different position method. A decision to restart the positioning attempt shall take into account the cause of the positioning failure as conveyed in the BSSLAP Reject or BSSLAP Reset.

6.5.2.7.11.2 Procedures in the VMSC

After the VMSC has requested a location estimate for a particular MS from the SMLC, certain events may occur that may temporarily or permanently interfere with the location attempt. For each such event notified to the VMSC, the VMSC shall employ one of the following error recovery actions.

(a) Restart the Location Attempt
This action shall be employed for any event that temporarily impedes a location attempt and cannot be delayed until the location attempt is complete. When such an event is notified to the VMSC, it shall immediately cancel the location attempt and the associated BSSMAP-LE dialogue with the SMLC (NSS based SMLC) or BSC (BSS based SMLC), if this still exists by sending a BSSMAP-LE UserPerform Location Abort message (in a TCAP Abort transaction) to the SMLC or BSC. The Abort message shall contain the reason for the location procedure cancellation. If the SMLC had previously returned a TCAP CONTINUE transaction to the VMSC within the MAP dialogue initiated by the VMSC, the Abort message would be conveyed immediately to the SLMC. If the SMLC had not returned any TCAP response to the VMSC, the Abort would not be conveyed immediately to the SMLC, although the TCAP dialogue with the SMLC would be terminated in the VMSC: the normal rules of TCAP then ensure that a TCAP provider Abort will be returned to the SMLC following the first TCAP response from the SMLC to the VMSC.

After aborting the location request dialogue with the SMLC or BSC, the VMSC mayshall queue the location request until the event causing the restart has terminated. The VMSC may optionally wait for an additional time period (e.g. if the queuing delay is minimal) to ensure that any resources allocated in and by the SMLC have time to be released. If the restart was instigated by the SMLC, the VMSC need not wait. The VMSC mayshall then send another location request to the SMLC or BSC associated with the current serving cell of the target MS.

(b) Abort the Location Attempt
This action shall be employed for any event that permanently impedes a location attempt, such as loss of the DCCH to the target MS. When such an event is notified to the VMSC, it shall cancel the current location attempt and the associated BSSMAP-LE dialogue with the SMLC (NSS based SMLC) or BSC (BSS based SMLC), if still existing, by sending a BSSMAP-LE Perform LocationUser Abort message (in a TCAP Abort transaction) to the SMLC or BSC. The Abort message shall contain the reason for the location procedure cancellation. The VMSC shall then return an error response to the client or network entity from which the location request was originally received. The VMSC shall also release all resources (e.g. DCCH) specifically allocated for the location attempt.

The following table indicates the appropriate error recovery procedure for certain events. For events not listed in the table (e.g. intra-BSC handover), the VMSC need take no action.

Event	VMSC Error Recovery
Release of radio channel to the MS	Abort

Any error response from the SMLC except for inter-BSC or inter-MSC handover~~restart~~	Abort
~~Error response from the SMLC requesting restart~~	~~Restart~~
Inter-BSC Handover	Restart after handover completed
Inter-MSC Handover	Restart after handover completed

Table 2 – LCS Error Recovery Procedures in the VMSC for certain Events

~~6.5.3.~~7.11.3 Procedures in an LMU

An LMU shall return an error indication to its controlling SMLC when location measurements previously ordered by the SMLC cannot be provided due to any error condition.

~~6.5.4.~~7.11.4 Procedures in the BSC

7.11.4.1 General Procedures

The BSC serving a target MS shall supervise any network or MS positioning procedure, including transfer of positioning assistance data to an MS, and shall only allow one such procedure to be active at any time. If a new procedure is instigated by the SMLC for any target MS, the BSC shall cancel any previous procedure without notifying the SMLC or target MS. The new procedure shall then be treated according to the prevailing conditions – e.g. may be rejected if a previous TOA handover attempt was not yet completed.

Depending on the position method and its current state of execution, a serving BSC may chose to defer ~~defer positioning request to handle~~ certain radio related events (e.g. handover) to avoid interference with location – refer to the later sections for each position method. A serving BSC shall abort all~~any~~ existing location related procedures for~~related to~~ a particular target MS ~~with or~~ without notifying an NSS based~~the~~ SMLC or target MS if the DCCH to the target MS or the SCCP connection to the VMSC or a BSS based SMLC is released. -In the event of an abort with a BSS based SMLC, the BSC shall attempt to notify the SMLC using a BSSMAP-LE Perform Location Abort.~~or if a new location procedure is instigated. A serving BSC shall return an error indication to the SMLC by sending a BSSMAP Location Information Report to the VMSC (see section 6.8) when any other event that cannot be deferred (e.g. handover) impedes the normal progress of a network based position method (e.g. TOA). The error indication shall indicate the nature of the event. In the case of intra-BSC handover or failure of handover, the serving BSC shall also notify the SMLC when the handover is complete (or has failed) by sending another BSSMAP Location Information Report to the VMSC. In the case of successful handover, this message shall also include the new serving cell ID and timing advance. It shall be left up to the SMLC to determine whether to cancel or continue with the location attempt when these indications are received. In the case of inter-BSC or inter-MSC handover, the original serving BSC shall abort the location procedure and will notify SMLC. Then SMLC will notify the failure of the location attempt to the positioning application. include an indication that network positioning has been interrupted in the data transferred to the new serving BSC to support handover (in the BSSMAP Handover Required message). In this case, the new serving BSC shall send the indication of handover completion together with the new serving cell ID and timing advance to the SMLC instead of the previous BSC. It shall be left up the SMLC to determine whether to cancel or continue with the location attempt when these indications are received.~~

7.11.4.2 Rejection of an SMLC Positioning Request

The BSC may reject any request from an SMLC for positioning or transfer of assistance data for a target MS if the request cannot be performed for reasons other than interaction with handover or other RR management. If the request is rejected, the BSC shall return a BSSLAP Reject to the SMLC containing the cause of rejection.

7.11.4.3 Interaction with Inter-BSC or Inter-MSC Handover

The BSC shall reject any request from an SMLC for positioning or transfer of assistance data while an inter-BSC or inter-MSC handover procedure is ongoing and shall return a BSSLAP Abort to the SMLC.

The BSC shall terminate any network or MS positioning procedure or any transfer of RRLP assistance data already in progress if inter-BSC or inter-MSC handover is needed and is not precluded by the particular positioning method and its current state. When positioning is terminated, the BSC shall return a BSSLAP Abort message to the SMLC after the

BSSMAP Handover Required has been sent to the serving MSC. The BSSLAP Abort shall contain the cause of the positioning failure.

7.11.4.37.11.4.4 Interaction with Intra-BSC Handover and other RR Management Procedures

The BSC shall reject any request from an SMLC for positioning or transfer of assistance data while an intra-BSC handover or other intra-BSC RR management procedure involving the target MS is ongoing and shall return a BSSLAP Reset to the SMLC when the handover or other RR management procedure is complete or has timed out in the BSC.

The BSC shall terminate any network or MS positioning procedure or any transfer of RRLP assistance data already in progress if an intra-BSC handover or other intra-BSC RR management proceedure is needed and is not precluded by the particular positioning method and its current state. When positioning is terminated, the BSC shall return a BSSLAP Reset message to the SMLC after the intra-BSC handover or other RR management procedure is complete or has timed out in the BSC. The BSSLAP Reset shall contain a cause indication, the current serving cell identity and may contain measurement information for the target MS (e.g. TA value).

7.11.5.7.11.5 Procedures in the Target MS

A target MS shall terminate any positioning procedure or the transfer of RRLP positioning assistance data without sending any response to the SMLC if any RR message is received from the BSC that starts some other RR management procedure, including a new positioning procedure. The new RR procedure shall then be executed by the MS.

7.11.6 Further Procedures for Handover

6.5.5.17.11.6.1 -MSC procedure for Inter-MSC Handover

When a location estimate is required for a target MS with an established call in a state of inter-MSC handover, the serving cell ID or serving location area ID shall be used by the visited MSC to identify the correct SMLC to perform the location. All layer-3 BSSMAP and DTAP Location request related messages that are transferred over the A-interface shall now be sent via MAP/E interface piggy-backed in MAP_FORWARD_ACCESS_SIGNALLING and MAP PROCESS_ACCESS_SIGNALLING between the visited and serving MSCs.

6.5.5.27.11.6.2 Handling of an ongoing handover while a request for positioning arrives at MSC/VLR

If during an ongoing radio handover procedure a request for location information arrives at the MSC/VLR, the request shall be suspended until the HANDOVER COMPLETE message is received at the MSC/VLR. On completion of the handover, the MSC/VLR shall issue continue with location preparation procedure.

6.5.5.37.12 Handling of an ongoing LCS procedure while handover is required

During an ongoing LCS procedure, if handover is required, LCS procedure shall be stopped until the handover is completed or rejected. The LCS procedure shall be initiated again or rejected after the completion or failure of the handover. The restart of the Location Procedure has been discussed in chapter 7.6.2.

6.6.Privacy

6.6.1.7.12.1 Privacy Override Indicator (POI)

The POI is used to determine whether the privacy settings of the subscriber to be positioned shall be overridden by the request for location services. The assignment of a POI value with an ‘override’ or ‘not override’ value in the LCS client profile is done during the LCS client provisioning. The type of LCS client requesting location information (i.e. commercial, emergency, law-enforcement etc.) shall determine the value of the POI assigned to the LCS client profile.

There are two distinct cases regarding the handling of the privacy override indicator.

***Procedure A**:* If the subscriber to be positioned is in the same PLMN or same country ast the GMLC then the POI shall override the subscriber's privacy options.

Procedure B: Otherwise the POI shall not override the subscriber's privacy options.

6.6.2.7.12.2 Privacy Procedures

The SLPP shall contain the privacy options defined in the HLR of the MS subscriber.
The SLPP shall be downloaded to the VMSC together with the rest of his subscription information in the existing MAP operation INSERT_SUBSCRIBER_DATA. It will be deleted with the existing MAP operation DELETE_SUBSCRIBER_DATA.

The POI is transferred from the GMLC to the VMSC in the location request. Based on the location of the GMLC the VMSC evaluates whether to accept or ignore the received POI according to the definition in Section 7.12.1.

If the POI is accepted the location requested is unconditionally performed. Otherwise if the POI is ignored the VMSC evaluates the privacy options in the MS subscriber's subscription profile (assuming this is held in the VLR). If the VLR does not contain the MS subscription profile, LCS will rely on the existing GSM recovery mechanisms to obtain the profile.

If the location request is allowed by the privacy options the location request is performed. Otherwise, if the location request is barred by the privacy options, the location request is refused an error response is returned to the GMLC with a cause code indicating that the request was rejected by the subscriber.

6.6.3.7.12.3 MS Privacy Options

The MS privacy options in the SLPP apply to an MT-LR or NI-LR and either indicate that no MT-LR or NI-LR is allowed for the MS (except as may be overridden by the POI or local regulatory requirements) or define the particular classes of LCS client for which an MT-LR or NI-LR for location and velocity areis allowed, with the following classes being possible:

(a) Universal Class – allow positioning by all LCS clients
(b) Call related Class – allow positioning by any LCS client to which the MS originated a call that is currently established
(c) Non-Call related Class – allow positioning by specific identified LCS Clients or groups of LCS Client with the following restrictions allowed for each identified LCS Client or group of LCS Clients
   - Location request allowed only from a GMLCs identified in the SLPPin the HPLMN
   - Location request allowed only from a GMLC in the home country
   - Location request allowed from any GMLC

   For each identified value added LCS client in the privacy exception list, allow one of two the following options:
   - notification: notify the MS of any allowed location request and provide the LCS client's identity
   - privacy verification: notify the MS of any allowed location request and provide the LCS client's identity, with the MS user enabled to accept or reject the request

   For all value added LCS clients sending a non-call related MT-LR, allow the following option:
   - privacy verification: notify the MS of any restricted location request and provide the LCS client's identity, with the MS user enabled to accept or reject the request. If this option is not subscribed to, a restricted location request shall be rejected without notification.
(d) PLMN operator Class – allow positioning by specific types of client within or associated with the VPLMN, with the following types of client identified:
   - clients providing a location related broadcast service
   - O&M client in the HPLMN (when the MS is currently being served by the HPLMN)
   - O&M client in the VPLMN
   - Clients recording anonymous location information without any MS identifier
   - Clients enhancing or supporting any supplementary service, IN service, bearer service or teleservice subscribed to by the target MS subscriber

If the MS subscribes to the universal class, any MT-LR or NI-LR shall be allowed by the VMSC. If local regulatory requirements mandate it, any MT-LR for an emergency services LCS client and any NI-LR for an emergency services call origination shall be allowed by the VMSC. If the MS subscribes to the call-related class, an MT-LR shall be allowed if the

MS previously originated a call that is still established and the called party number either dialed by the MS or used by the VMSC for routing matches the called party number received from the GMLC. If the MS subscribes to the non-call related class, an MT-LR shall be considered as allowed by the network if the identity of the LCS client or LCS client group supplied by the GMLC matches the identity of any LCS Client or LCS Client group contained in the MS's SLPP and any other restrictions associated with this LCS Client identity in the SLPP are also met. Otherwise, the MT-LR shall be considered to be restricted. If an MT-LR from a value added LCS client is allowed and the MS subscribes to privacy verification for this LCS client, the MS shall be notified and enabled to accept or reject the MT-LR. If a non-call related MT-LR from any value added LCS client is restricted and the MS subscribes to privacy verification for value added all LCS clients, the MS shall be notified and enabled to accept or reject the MT-LR. In the event of no response from the MS user in either of these cases, the restriction or allowance of the MT-LR shall remain unchanged. If the MS subscribes to the PLMN class, an NI-LR or MT-LR shall be allowed if the client within the VPLMN, for an NI-LR, or the client identified by the GMLC, for an MT-LR, either matches a generic type of client contained in the MS's SLPP or is otherwise authorized by local regulatory requirements to locate the MS.

In evaluating privacy where any address "A" associated with the LCS client (e.g. LCS client ID or GMLC address) needs to be compared with a corresponding address "B" in the target MS's SLPP, a match shall be determined if a match is found for each of the following components of each address:

(a) Numbering Plan
(b) Nature of Address Indicator
(c) Corresponding address digits for all digits in "B" (the digits or initial digits in "A" must match all the digits in "B", but "A" may contain additional digits beyond those in "B)

All addresses shall be transferred to the MSC/VLR in international format,

~~6.7.~~7.13 Mobile Originating Location

An MS may subscribe to any of the following classes of mobile originating location:

A) Basic Self Location
B) Autonomous Self Location
C) Transfer to Third Party

An MO-LR shall be allowed by the VMSC if the type of request is supported by the appropriate subscription according to the following table.

Type of MO-LR Request	Required MS Subscription
MS requests own location	Basic Self Location
MS requests location assistance data	Autonomous Self Location
MS requests transfer of own location to another LCS Client	Transfer to Third Party

Table X – Required MS Subscription Options for MO-LR Requests

~~**Editorial Note:** the procedures described in this section reflect the agreements in the LCS interim meeting in Dallas on August 10-13. Since not all aspects of RR management interactions were agreed (e.g. concerning TOA), placeholders have been left for future contributions.~~

~~**Note to Stage 2 Editor:** the procedures here can be included into section 6.5 of the stage 2 (03.71) together with other changes agreed during the August 10-13 meeting for this section. Ensuring consistency between these two sets of changes seems to be editorial. Ensuring consistency with other text already in section 6.5 and not yet changed can be dealt with by contributions to the next meeting.~~

~~The procedures defined in this section are applicable to all position methods.~~

Procedures in the SMLC

If the SMLC receives an abort indication from the BSC serving the target MS (e.g. due to inter-BSC or inter-MSC handover), it shall terminate the positioning attempt and return a positioning failure indication to the VMSC with the cause indicated by the BSC. Any dialogues already established with LMUs to perform positioning of the target MS may be aborted.

Procedures in the VMSC

Add the following to the table in section 6.5.2 regarding VMSC recovery actions:

Event	VMSC Error Recovery
Inter-BSC Handover	Restart after handover completed
Inter-MSC Handover	Restart after handover completed

Procedures in the BSC

The BSC serving a target MS shall supervise any network or MS positioning procedure, including transfer of positioning assistance data to an MS, and shall only allow one such procedure to be active at any time. <placeholder to define BSC actions when positioning is requested by an SMLC with a previous positioning procedure still active in the BSC>

The BSC serving a target MS shall reject any request from an SMLC to start network (e.g. TOA or TA) positioning or transfer an RRLP positioning command or positioning assistance data to the target MS if another RR management procedure is already being executed for the target MS. The BSC shall then return an explicit BSSLAP reject for a network positioning request or a BSSLAP Abort for an RRLP positioning message.

Editorial Note: the above is consistent with our agreements, although its extension to cover TA was not discussed.

The BSC serving a target MS shall immediately terminate any network or MS positioning procedure or any transfer of RRLP assistance data if another RR management procedure needs to be instigated. The only exception is TOA after a handover command has been sent to the target MS when other RR management procedures shall be delayed until the TOA handover procedure is complete. If positioning is terminated due to an inter-BSC or inter-MSC handover, the BSC shall return a BSSLAP Abort to the SMLC with a cause parameter indicating inter-BSC handover. If positioning is terminated due to some other intra-BSC RR management procedure, <placeholder for future text>.

Procedures in the Target MS

A target MS shall terminate any positioning procedure or the transfer of RRLP positioning assistance data without sending any response to the SMLC if any RR message is received from the BSC that starts some other RR management procedure, including a new positioning procedure. The new RR procedure shall then be executed by the MS.

7.14 CM Procedures

6.7.1. 7.14.1 Location request for a mobile in idle-mode

When a request for location information is received at the VMSC the LCS-layer shall order paging of the MS subscriber. In case of first unsuccessful paging, normal paging procedures should apply. After successful paging the LCS-layer shall invoke the location preparation procedure.

6.7.2.7.14.2 Location request for a mobile in dedicated-mode

When a request for location information is received at the VMSC, if the MS is already busy on CM level, the LCS-layer shall attempt to establish a parallel transaction to the existing one. If successful, the LCS-layer shall invoke the location preparation procedure.

6.8.Common Procedures to support SMLC to BSS Signaling

6.8.1.SMLC to BSC Information Transfer Procedure

The SMLC to BSC Information Transfer Procedure enables location related commands, responses and control information to be transferred between an SMLC and the serving BSC for a target MS via the visited MSC. The procedures apply to network based positioning methods like TOA and TA. The procedures are only valid during the lifetime of the MAP transaction between the SMLC and visited MSC for the target MS that is initiated by the transfer of a MAP Perform Location request from the VMSC to the SMLC and terminated, normally, by the return of a MAP Perform Location response.

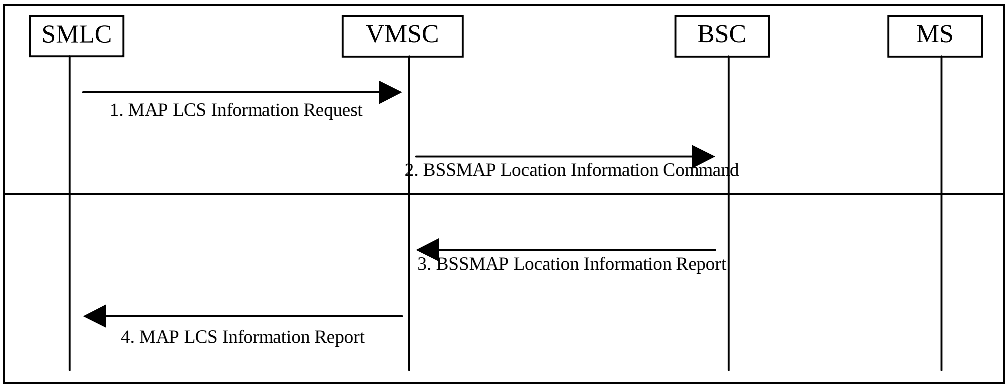


Figure 11 SMLC to Serving BSC Information Transfer Procedure

(1)The SMLC sends a MAP LCS Information Request to the visited MSC serving a particular target MS. This message shall be linked to the MAP Perform Location request previously transferred from the VMSC toi SMLC. It contains location related information intended for the serving BSC.
(2)The VMSC transfers the location related information received in step 1 to the serving BSC for the target MS in a BSSMAP Location Command. Steps 1 and 2 may be repeated if the SMLC needs to transfer further location information to the serving BSC.
(3)Some time after receiving the location information in step 2, the BSC may return location response information to the SMLC by sending a BSSMAP Location Information Report to the VMSC containing this information.
(4)If the MAP transaction with the SMLC to perform positioning for the target MS is no longer open, the VMSC shall discard the message received in step 3. Otherwise, the VMSC shall transfer any location response information received in step 3 to the SMLC in a MAP LCS Information Report. This message shall be associated with the MAP transaction currently established between the VMSC and SMLC for positioning the target MS.

6.8.2.SMLC to BSC Report Error Procedure

The SMLC to BSC report error procedure may be optionally requested by an SMLC when attempting to transfer LCS Information to a particular serving BSC via the VMSC for a certain target MS. If the procedure is requested and the VMSC cannot transfer LCS Information to the serving BSC, an LCS error indication is returned to the SMLC together with the content of the original LCS Information Request sent earlier by the SMLC.

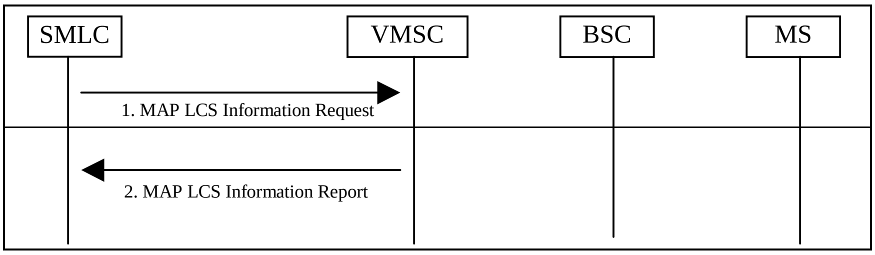


Figure 12 SMLC to BSC Report Error Procedure

(1)The SMLC sends a MAP LCS Information Request to the visited MSC serving a particular target MS. This message shall be linked to the MAP Perform Location request previously transferred from the VMSC toi SMLC. It contains location related information intended for the serving BSC and a "report error" indication.

(2)If the location information received in step 1 cannot be successfully transferred to the serving BSC for the target MS (e.g. due to errors in the received message) and provided the "report error" indication was sent in step 1, the VMSC returns a MAP LCS Information Report to the SMLC containing the same location information received in step 1 and the cause of the error. This message shall be associated with the MAP transaction currently established between the VMSC and SMLC for positioning the target MS. The SMLC may use the content of the location information for correlation with the information sent in step 1.

6.9. Common Procedures for a Circuit Mode LMU

6.9.1. Architectural requirements

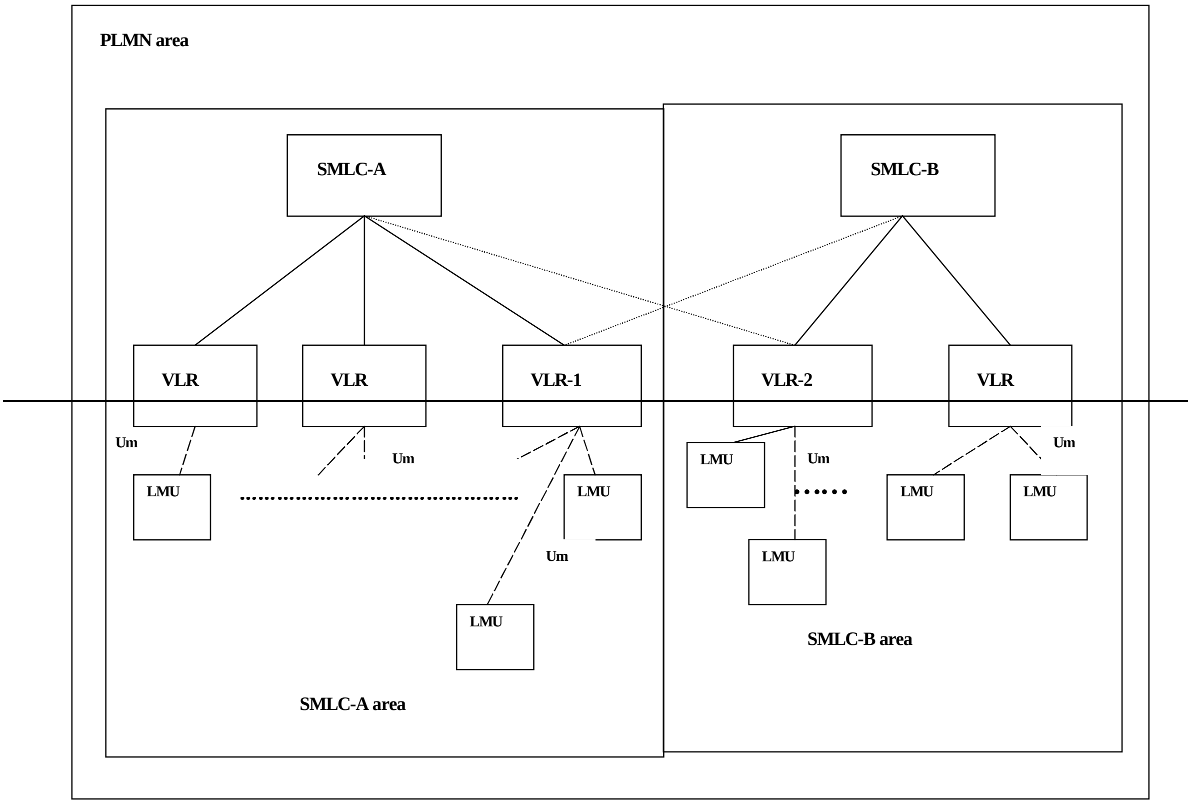


Figure 11: Association between LMU(s) and SMLC(s) through various VLR(s)

~~6.9.1.1SMLC requirements~~

~~(1)A PLMN consists of one or more SMLC(s). There is no direct connection between SMLC(s) within a PLMN.~~
~~(2)An SMLC area is associated with one or more VLR areas within a PLMN.~~
~~(3)An SMLC area consists of location areas (LA). A LA shall be controlled by only one SMLC.~~
~~(4)An LMU belonging to SMLC-A shall register with SMLC-A even if the registration is done via VLR-2 due to radio conditions, see figure 3.1. An SMLC behaves as the ‘home" for all LMU(s) belonging to that SMLC.~~
~~(5)An SMLC shall select the LMUs that are best suited to perform measurements for the target MS according to the serving cell of and other radio related information available to the SMLC.~~
~~(6)The LMU registration is done either by deriving the SMLC address from the LMU ISMI or by an association existing in the VLR between the serving cell id and its associated SMLC.~~

~~6.9.1.2LMU requirements~~

~~(1)An LMU is registered at a VLR depending on the radio conditions as described in GSM TS 03.22;~~
~~(2)An LMU shall behave as an MS unless otherwise stated;~~
~~(3)An LMU shall register at ‘home’ SMLC determined by its IMSI or at the SMLC associated with the LMU’s current serving cell id;~~
~~(4)In addition to the MM common procedures an LMU shall support the following MM specific procedures:~~

~~- Location updating procedure,~~
~~- Periodic updating~~
~~- IMSI attach procedure~~

~~as specified in GSM TSs 04.08 “Mobile Radio L3 interface” and 09.02 “Mobile Application Protocol (MAP) specification”;~~

~~(5)LMU handovers shall be supported (both intra and inter MSC);~~
~~(6)It shall be optional whether an LMU shall support the IMSI attach/detach procedure;~~
~~(7)The MAP Cancel Location operation shall not cause de-registration of an LMU from its SMLC;~~

~~6.9.1.3 VLR requirements~~

~~(1)A VLR may be associated with one or more SMLC(s).~~
~~(2)Based on the serving cell-id of the target MS, the VLR shall select the SMLC to send the request for positioning measurements.~~
~~(3)It is an MSC/VLR implementation option whether the VLR shall be able to derive the SMLC address of the LMU by using the LMU IMSI number or by using the serving cell id, which has an association to an SMLC defined in the VLR.~~
~~(4)If the indicator “Location Information Confirmed in SMLC” is set to “Not Confirmed” then the VLR shall order registration of the LMU at the SMLC at the next LMU originating transaction or SMLC terminating transaction.~~
~~(5)In case of an LMU begin detached (i.e. IMSI detach flag is set) the VLR shall reject all transactions towards the LMU being in detach state.~~

~~6.9.1.4HLR requirements~~

~~It shall be able to distinguish between an MS and an LMU.~~

~~6.9.2. LMU registration~~

~~The registration is used to indicate to an SMLC that an LMU is available and provides the SMLC the address of the serving MSC/VLR.~~

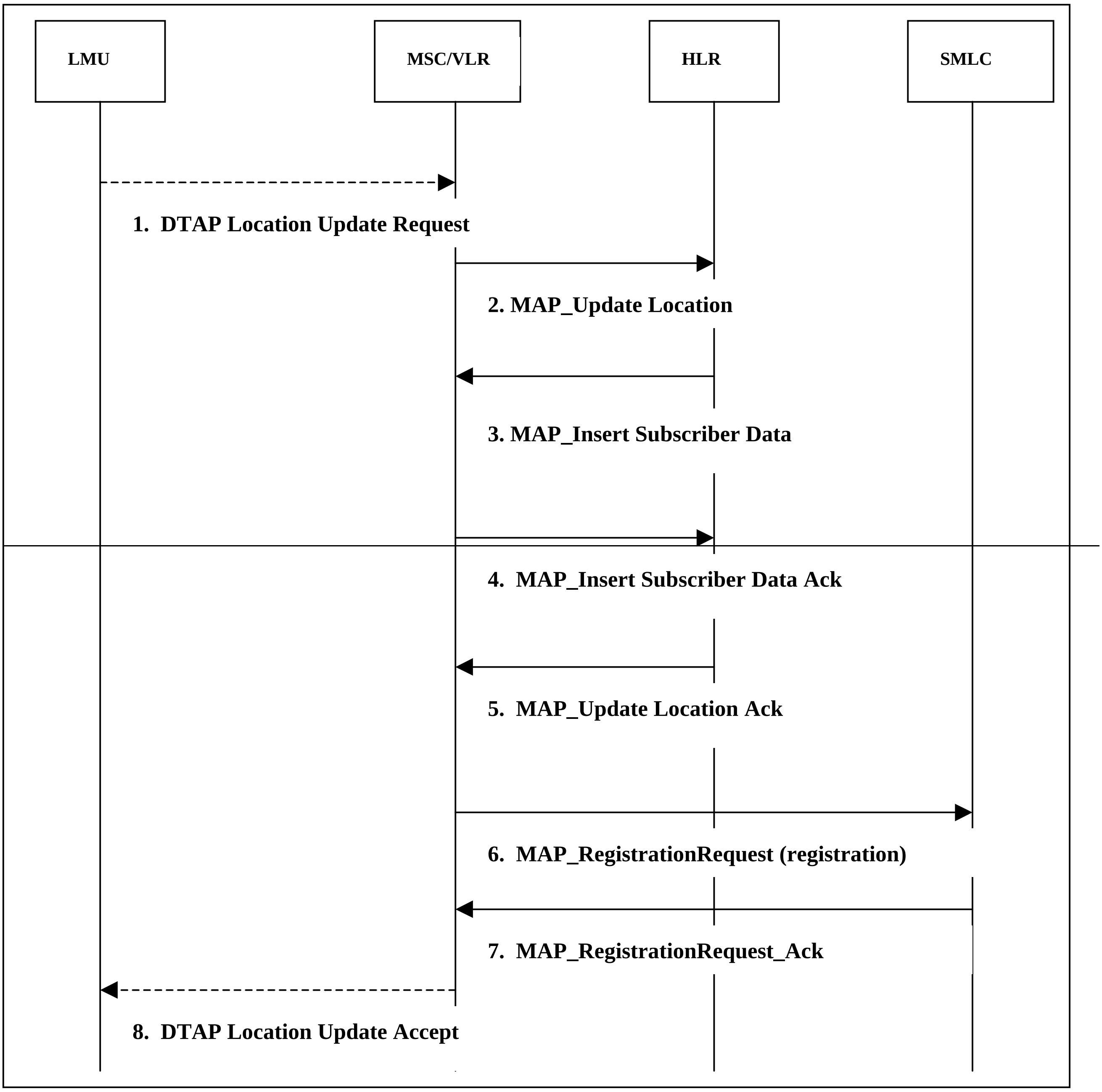


Figure 12: Registration of an LMU at SMLC following location update

The LMU shall perform location updating according to GSM TS 03.22 and 04.08 MM specific and common procedures.

The SMLC shall be registered in the following cases:

- when the LMU registers in a new VLR i.e. the VLR has no data for that LMU;
- when the LMU registers in a new location area of the same VLR and the MSC area has changed;
- if the indicator "Location Information Confirmed in SMLC" is set to "Not Confirmed" because of a VLR or SMLC restart see TS GSM 03.07 for further details;

(1)On reception of the existing DTAP CM Service Request the visiting MSC derives the address of SMLC either form the LMU IMSI or from the serving CI of the LMU.
(2)Next, the location update to the HLR is performed according to procedures described in GSM TS 09.02.
(3)The operation MAP Update Location initiates the MAP Insert Subscriber Data operation, which informs the VLR of any LMU related data.

(4)On successful downloading of the LMU data, the VLR shall send the acknowledgement to the HLR in MAP Insert Subscriber Data Ack.

(5)On successful location updating at the HLR, the existing message MAP Update Location Ack is returned to the VLR.

(6)After successfully updating the HLR, the VLR shall order registration of the LMU at the selected SMLC by sending with the message MAP_RegistrationRequest which includes the address of the MSC, the IMSI of the LMU and possibly the LMSI.

(7)The SMLC performs the registration of the LMU and acknowledges the operation to the VLR in the MAP_RegistrationRequest Ack message. In case of failure of the registration, i.e. in case no reply is sent to the VLR or a delayed reply to the VLR, will cause timeout at the VLR. The procedure shall be repeated at the next location update (IMSI attach, Periodic or Normal location update). The indicator “Location Information Confirmed in SMLC” remains to “Not Confirmed”.

(8)On successful LMU registration at the selected SMLC, the VLR shall complete the location update procedure by sending the existing layer 3 message Location Update Accept to the LMU.

6.9.3. LMU Deregistration

De-registration is used to inform an SMLC that an LMU is currently unavailable. Note that de-registration does not necessarily imply that an LMU may have failed (e.g., de-registration may occur due to MAP Cancel Location operation)

6.9.3.1Purging an LMU

This service is used between the VLR and the SMLC to cause the SMLC to mark its data for an LMU so that any request for performing measurements for a target MS or any other diagnostics will be treated as if the LMU is not reachable. It is invoked when the subscriber (LMU) record is to be deleted in the VLR, either by MMI interaction or automatically e.g. because the LMU has been inactive for certain period of time.

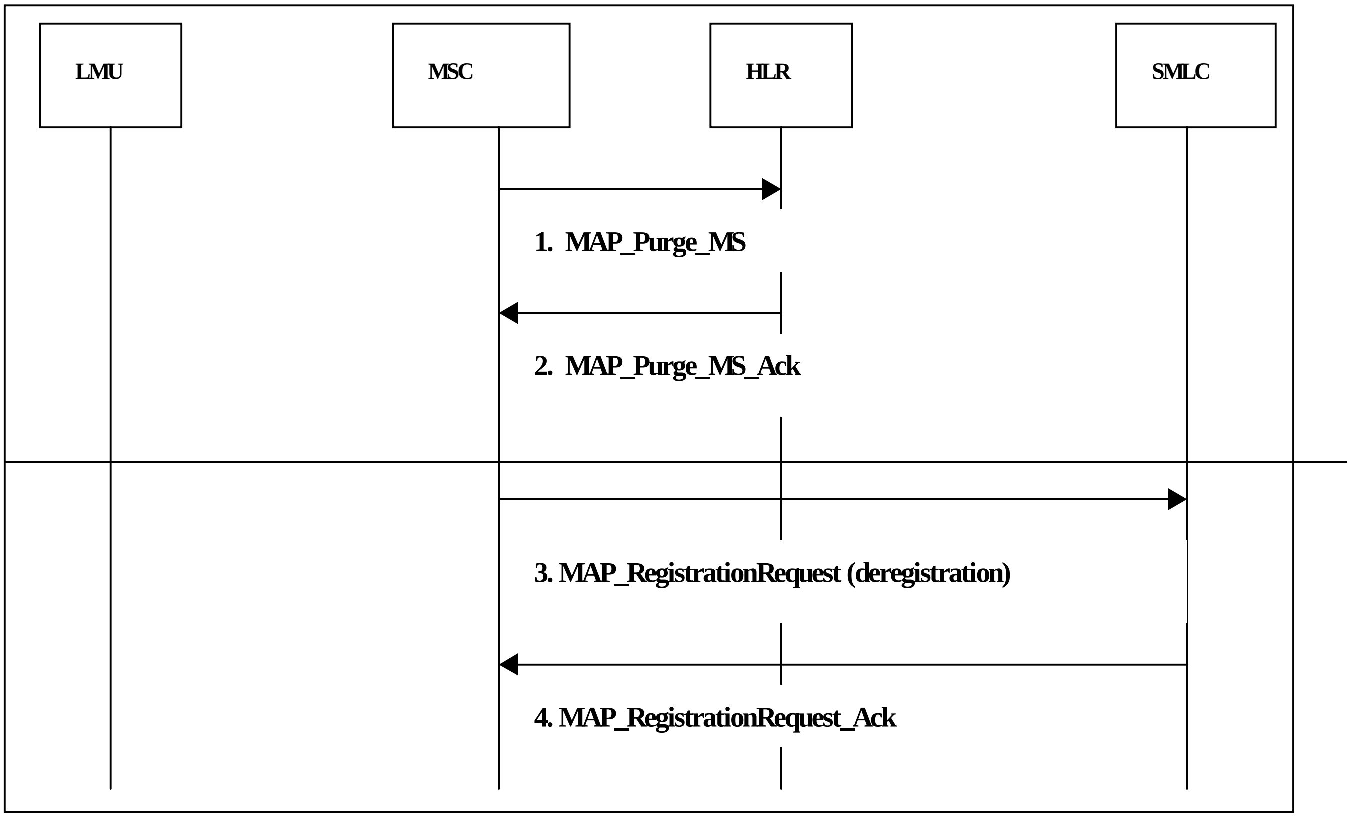


Figure 13: De-registration of an LMU due to purging

(1)Due to automatic de-registration or due to manual de-registration an LMU a command is send to HLR to purge an LMU in MAP_Purge_MS
(2)After the LMU data is purged, the HLR acknowledges the purging in MAP Purge_MS_Ack.
(3)On reception of the acknowledgment from HLR, the VLR initiates de-registration of the LMU from its serving MLC (SMLC) by sending the new message MAP_RegistrationRequest carrying an indication of deregistration.
(4)The SMLC deletes the LMU from its database and sends an acknowledgement to the VLR in the message MAP_RegistrationRequest_Ack

6.9.3.2Cancel Location

Normally, de-registration of an LMU from the SMLC shall not be done when an LMU performs a location update from an old VLR to a new VLR (since an LMU has a 'home' SMLC).

In some cases a cancel location operation may be used by operator determined purposes to delete the subscriber's (LMU) record from the network. In that case, the VLR shall instigate the de-registration procedure to delete the registration of an LMU at the SMLC.

The HLR shall indicate in the cancellation type (cancellation type = subscription withdrawn) that the cancel location operation is initiated e.g. by the operator to withdraw the subscription of the LMU. Depending on the cancellation type the VLR shall determine whether de-registration of an LMU to the SMLC, following a cancel operation, shall be done or not.

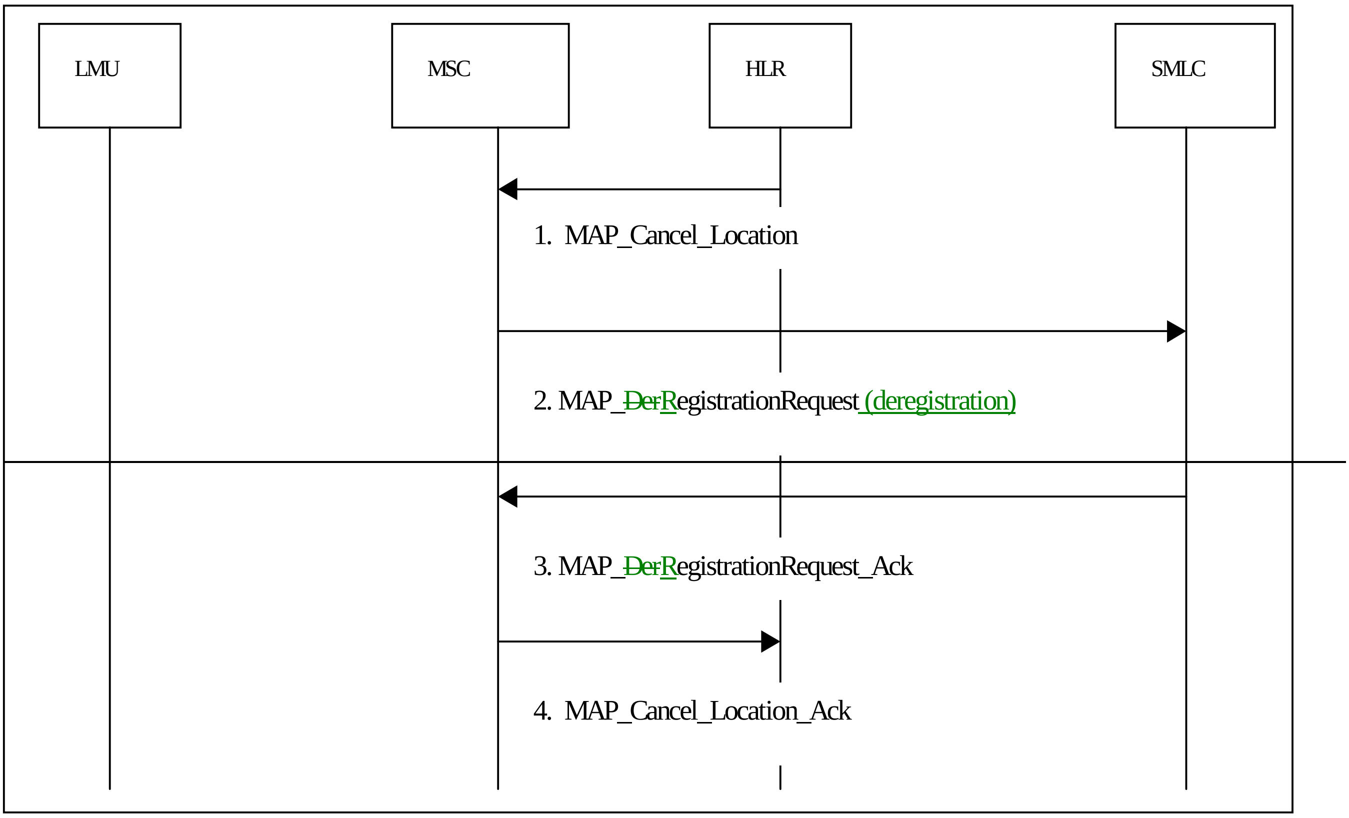


Figure 14: De-registration due to Cancel Location operation

The steps below assume that the cancellation type indicates cancellation type = subscription withdrawn.

(1)The HLR orders in MAP_Cancel_Location a VLR to cancel the LMU data due to the LMU's registration in a new VLR area.
(2)If the cancel operation is related to an LMU and the cancellation type indicates "subscription withdrawn", the VLR orders de-registration in the message MAP_RegistrationRequest. The registration type in this message indicates deregistration.
(3)After the LMU subscription is withdrawn, the SMLC acknowledges the withdrawal in MAP_RegistrationRequest_Ack.
(4)On reception of the acknowledgment from SMLC, the VLR sets the indicator "Location Information Confirmed in SMLC" to "Not Confirmed" and then acknowledges the cancel location operation to the HLR in the existing message MAP_Cancel_Location_Ack.

6.9.4.LMU-SMLC Information Transfer Procedure

The LMU-SMLC information transfer procedure is a generic procedure applicable to all circuit mode LMUs. It allows an SMLC to either invoke or terminate particular types of location measurement or O&M activities in the LMU and allows the LMU to return location measurement or O&M results. If an LMU is pre-administered with all necessary data regarding the required location measurements or O&M activities, a measurement or O&M command from the SMLC would not be mandatory. Because the procedure is generic, the exact content of the MAP and DTAP messages used to convey measurement and O&M commands and responses can vary between different position methods. The permanence of the SDCCH connection to the LMU is determined as follows:

(a)For an LCS information request from the SMLC to the LMU, the SMLC indicates if the LMU must retain the SDCCH. If this indication is provided, the LMU shall not initiate release of the current SDCCH after the LCS information request has been transferred. If the indication is not provided, the LMU may initiate release if the SDCCH is not needed at this time by the LMU.

(b)For an LCS information response from the LMU to the SMLC, the LMU shall release or not release the current SDCCH after the message has been transferred according to the absence or presence, respectively, of the "Release Forbidden" indicator in the last LCS information request received from the SMLC. If there was no previous LCS information request (e.g. the LMU was recently powered on), the LMU shall assume permission to release.

(c)Following handover of an SDCCH to a new serving BTS, an LMU may instigate release of the SDCCH, even when the SMLC forbade SDCCH release, if the handover condition persists with the new BTS for more than a certain time interval.

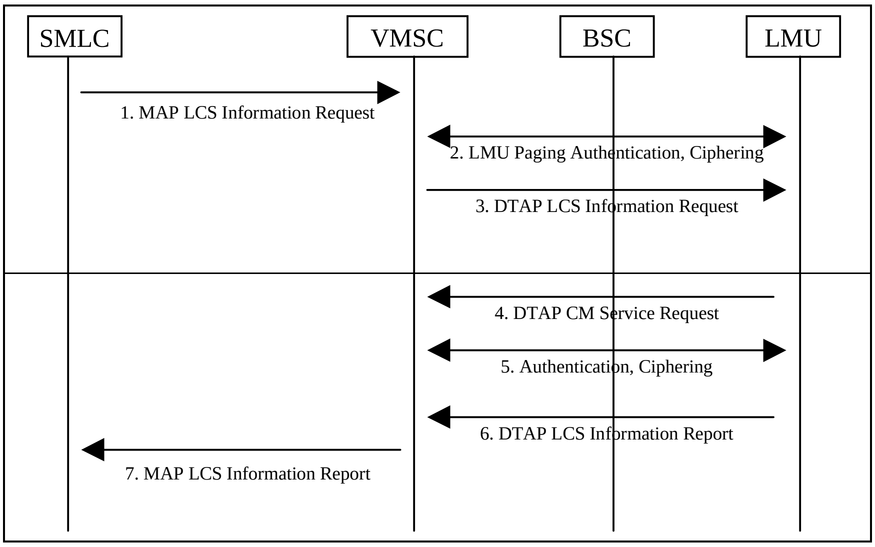


Figure 15 Information Transfer Procedure for a Circuit Mode LMU

(1)The SMLC sends a MAP LCS Information Request to the MSC serving a particular LMU defining which location measurements or O&M actions should be started or stopped in the LMU and providing any data needed by the LMU to achieve this. Data related to periodic measurements or O&M actions (e.g. frequency, duration and filtering) may also be included. If this data exceeds the size of a single MAP message, further MAP LCS Information Request messages may be sent. The IMSI or LMSI identity of the LMU shall be conveyed in the LCS Information Request. In addition, the SMLC may indicate in the last LCS Information Request message that the LMU shall not release the SDCCH.

(2)If there is no SDCCH and mobility management connection to the LMU (e.g. LMU uses a temporary SDCCH), the serving MSC performs paging, authentication and ciphering to assign an SDCCH and establish a MM connection.

(3)The serving MSC passes the location instructions and data received from the SMLC to the LMU in either one DTAP LCS Information Request message for each received MAP LCS Information message. The last DTAP LCS Information Request shall indicate that the LMU shall not release the SDCCH if this was indicated by the SMLC. Once all the data is received, the LMU may initiate release of the CM and MM connections and the SDCCH, according to the procedures in GSM 04.71, if the information response in step 6 is not needed immediately and if the information response in step 6 is not needed immediately and the SMLC did not forbid release of the SDCCH.

(4)When the LMU has location measurement or O&M data to report and does not currently have an SDCCH and MM connection to the serving MSC, it requests an SDCCH and sends a DTAP CM Service request to the serving MSC to request an MM connection for location services.

(5)In response to any CM Service Request, the serving MSC performs authentication and ciphering for the LMU.

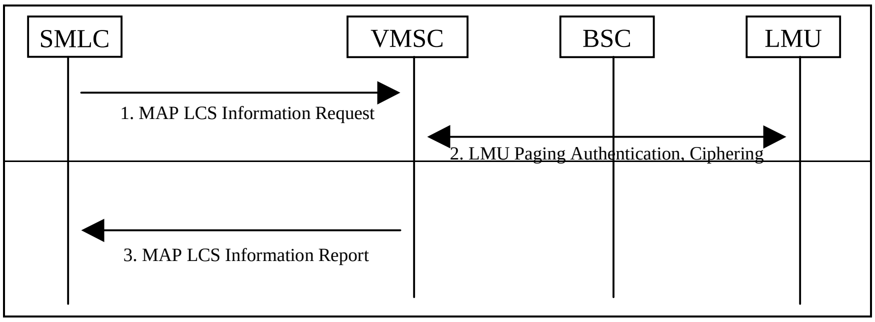
(6)The LMU sends a DTAP LCS Information Report to the serving MSC containing its location measurement or O&M results. If necessary, more than one of these messages may be sent to transfer a large quantity of data. Each Information Report may indicate the identity of the associated SMLC. The LMU may then release the MM connection to the MSC and the SDCCH if the SMLC did not forbid release of the SDCCH in step 3.

(7)The serving MSC forwards the contents of each separate Information Report to the SMLC with which the LMU is registered in a MAP LCS Information Report. This message shall also include the IMSI of the sending LMU.

6.9.5.SMLC Report Error Procedure

The SMLC report error procedure may be optionally requested by an SMLC when attempting to transfer LCS Information to a particular LMU via its serving MSC. If the procedure is requested and the serving MSC cannot transfer LCS Information to

~~the specified LMU, an LCS error indication is returned to the SMLC together with the content of the original LCS Information Request sent earlier by the SMLC.~~



~~**Figure 16 Report Error Procedure for a Circuit Mode LMU**~~

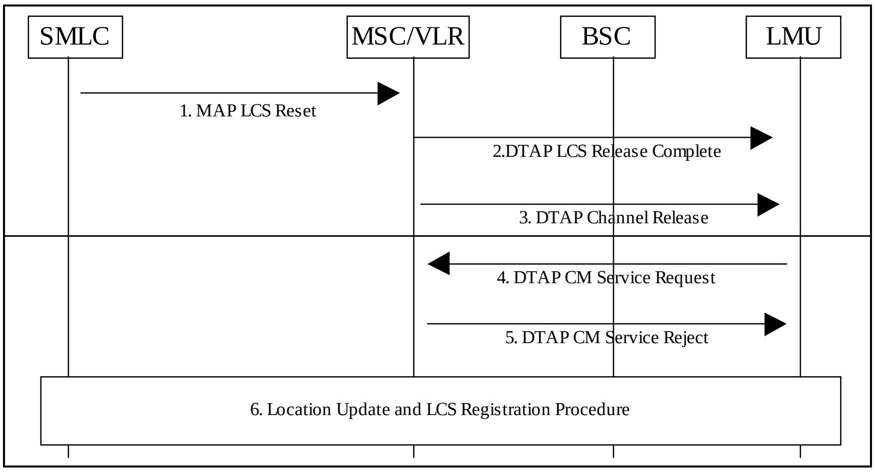
~~(1)The SMLC sends a MAP LCS Information Request to the MSC serving a particular LMU defining which location measurements or O&M actions should be started or stopped in the LMU and providing any data needed by the LMU to achieve this. This message includes the IMSI and possibly LMSI identification of the target LMU and may include a report error indication.~~

~~(2)If the LMU is unknown to the serving MSC and a report error indication was included in step 1, the serving MSC shall return a MAP LCS Information Report message to the SMLC. This message shall contain the IMSI of the intended LMU, the location measurements or O&M data received in step 1 and the error cause. The SMLC may use the contents of the location or O&M data returned to correlate the Information Report with the specific LCS Information request sent earlier. Otherwise, if the LMU is known to the serving MSC but there is no SDCCH and mobility management connection to the LMU (e.g. LMU uses a temporary SDCCH), the serving MSC performs paging, authentication and ciphering to assign an SDCCH and establish a MM connection.~~

~~(3)If paging, or authentication is unsuccessful or if the LCS information cannot be transferred for some other reason, and the SMLC has requested an error report, the serving MSC shall return a MAP LCS Information Report message to the SMLC with the contents described in step 2. If paging and authentication are successful, the MSC transfers the location measurement or O&M data to the LMU as described in section 6.8.4.~~

~~6.9.6.SMLC Data Restoration Procedure~~

~~The SMLC data restoration procedure enables restoration of the registration status of one or more LMUs in an SMLC following either memory loss or data inconsistency in the SMLC. The procedure may be directed to either a particular identified LMU, a specific set of LMUs or to all LMUs served by an MSC that are registered with the SMLC.~~



~~**Figure 17 SMLC Data Restoration Procedure**~~

(1)An SMLC sends a MAP LCS Reset message to a particular VLR. The message carries the identity of the SMLC and may carry the identities for a set of LMUs sharing this SMLC. If no LMU identities are indicated, steps 2 to 8 apply to each LMU served by the MVLRSC that is registered with the SMLC. If one or more LMUs are indicated, steps 2 to 8 apply only to those LMUs identified by the SMLC that are served by the VLR and registered in the SMLC.

(2)For any LMU identified in step 1, the VLR shall reset the "location information confirmed in SMLC" indicator to "not confirmed". If the LMU currently has a LCS CM connection established to the serving MSC, the MSC shall send a DTAP LCS Release Complete to the LMU to release the LCS CM and MM connection. The cause in the Release Complete shall indicate "not registered in SMLC".

(3)If the MSC sends an LCS Release Complete in step 2 and there are no other (non-LCS) CM and MM connections between the MSC and LMU, the MSC may instigate release of the RR connection (e.g. SDCCH) by sending a DTAP Channel Release to the LMU.

(4)The LMU may later request the establishment of a LCS MM connection (e.g. if there was no connection to release in steps 2 and 3) by sending a DTAP CM Service Request to the MSC indicating a request for LCS.

(5)The MSC shall respond to any CM Service Request for LCS by returning a DTAP CM Service Reject with a cause of "not registered in SMLC".

(6)In response to either the release in steps 2 and 3 or the CM Service Reject in step 5, the LMU shall instigate the location registration and LCS Registration procedure described in section 6.8.2 (LMU registration). In response to a successful LCS registration, the SMLC may reset the LMU as described in section 6.8.7.

6.9.7.Reset Procedure

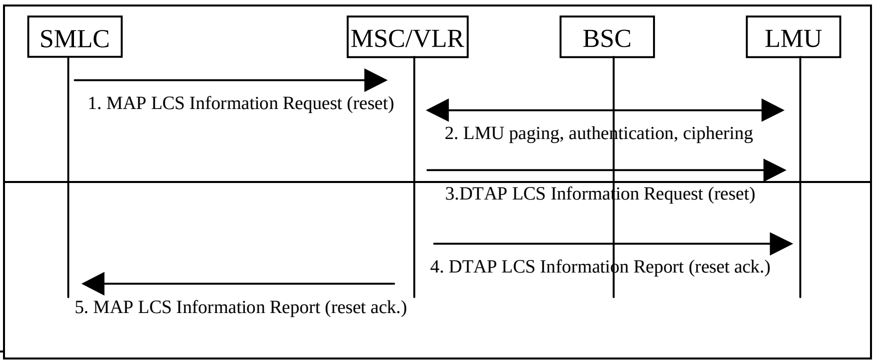


Figure 18 Reset Procedure for a Circuit Mode LMU

(1)The SMLC sends a MAP LCS Information Request message to the MSC currently serving the LMU. This message carries the IMSI of the LMU and indicates if the LMU shall not release the SDCCH. The message also carries a LCS O&M reset operation.

(2)If the LMU is known to the MSC but currently has no SDCCH and mobility management connection, the serving MSC performs paging, authentication and ciphering to assign an SDCCH and establish a MM connection. If there is no response to paging or the LMU was unknown to the MSC, the LCS Information Request is discarded. In that case, the SMLC may timeout on the expected reply and infer that the LMU is unreachable.

(3)Assuming the LMU is reachable and an SDCCH was established, the MSC sends a DTAP LCS Information Request to the LMU carrying the LCS O&M reset. This message carries an "Release Forbidden" indicator if this was received in step 1.

(4)The LMU cancels all LCS measurement and O&M tasks previously ordered by the SMLC. The LMU then returns a DTAP LCS Information Report carrying a LCS O&M reset acknowledge. The LMU may then initiate release of the current SDCCH if the SMLC did not forbid this.

(5)The MSC forwards the reset acknowledge received from the LMU to the SMLC inside a MAP LCS Information Report.

6.9.8.Status Query Procedure

The Status Query procedure enables an SMLC to verify the status of an associated LMU. The procedure may be instigated periodically or following any loss of communication with the LMU.

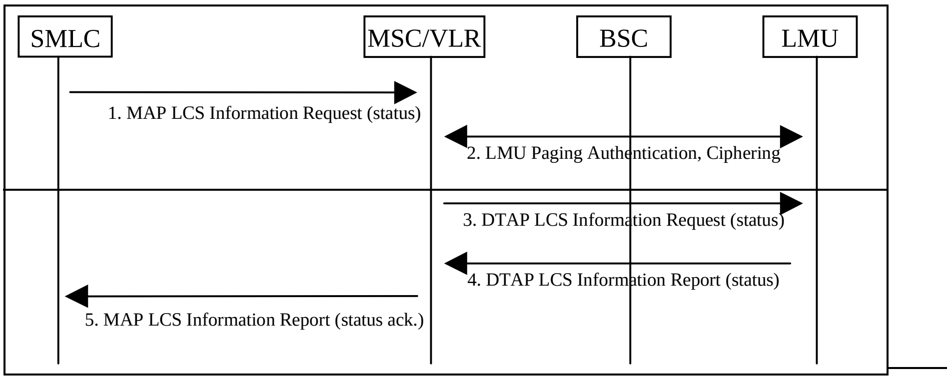


Figure 19 Status Query Procedure for a Circuit Mode LMU

(1)The SMLC sends a MAP LCS Information Request message to the MSC currently serving the LMU. This message carries the IMSI of the LMU and indicates if the LMU shall not release the SDCCH. The message also carries a LCS O&M status query. The message may also carry a "report error" indication to insure a response even when the serving MSC cannot forward the status query to the LMU (see section on Report Error procedure).
(2)If the LMU is known to the MSC but currently has no SDCCH and mobility management connection, the serving MSC performs paging, authentication and ciphering to assign an SDCCH and establish a MM connection. If there is no response to paging or the LMU was unknown to the MSC, the LCS Information Request is discarded. In that case, the SMLC may timeout on the expected status reply and infer that the LMU is unreachable.
(3)Assuming the LMU is reachable and an SDCCH was established, the MSC sends a DTAP LCS Information Request to the LMU carrying the LCS O&M status query. This message carries an "Release Forbidden" indicator if this was received in step 1.
(4)The LMU returns a DTAP LCS Information Report carrying a LCS O&M status response. This LCS O&M response indicates the number of active measurement jobs and number of active O&M jobs in the LMU that were previously ordered by the SMLC. The LMU may then initiate release of the current SDCCH if the SMLC did not forbid this.
(5)The MSC forwards the status response received from the LMU to the SMLC inside a MAP LCS Information Report.

6.10.7.15 Radio Interface Timing Procedures

The Radio Interface Timing determination system consists of functions in LMUs and in the SMLC. The system runs continuously offering base station synchronization information for mobile station location.

6.10.1.7.15.1 LMU Functions

The Radio Interface Timing functionality in the LMU must be capable of performing the following functions:

- The LMU performs necessary air interface measurements from signals transmitted by base stations (both serving and neighbor). These signals can be normal bursts, dummy bursts, and synchronization bursts on the BCCH frequency.
- If the LMU contains the common reference clock, it time stamps reception of BTS signals.
- If there is no reference clock available, the LMU makes Real Time Difference measurements, i.e. measures the time difference between arrival of bursts from two base stations (e.g. serving and one of neighbors)
- The LMU performs some processing of measurements, like averaging and filtering, using parameters delivered to it, or in their absence using default settings.

6.10.2.7.15.2 SMLC Functions

The SMLC must be capable of performing the following functions related to Radio Interface Timing determination:

- The SMLC sends to LMUs requests for Radio Interface Timing measurement information.
- The SMLC will communicate continuously with LMUs; thus, the SMLC can monitor operation of LMUs. If a LMU fails to send Radio Interface Timing information, the SMLC shall try to restart the LMU, and if this restarting fails, the SMLC shall inform O&M system. SMLC can use also diagnostics messages to query the status of LMUs.

- The SMLC receives Radio Interface Timing measurement results from LMUs.
- The SMLC stores or queries extra information required for base station synchronization determination, like base station and LMU coordinates, base station identity information (LAC, CI, BSIC, carrier), and burst length schemes.
- The SMLC determines synchronization differences between base stations using measurements and other information.
- Synchronization information is delivered for mobile station location purposes.

6.10.3.7.15.3 LMU-SMLC Interactions

The request for Radio Interface Timing measurement information from the SMLC to a LMU contains the following parameters:

- Measurement type. This indicates whether the SMLC wants the LMU to perform Absolute Time Difference (ATD) or Real Time Difference (RTD) measurements.
- Measurement result reporting frequency. This indicates how often the LMU should send Radio Interface Timing measurement results.
- Measurement duration. This indicates how long the LMU should make measurements and report results.
- Instructions about filtering of raw measurement data.
- Instructions about base stations to be measured. The LMU unit can measure autonomously a certain number of most strongly received base stations. Another possibility is that the SMLC tells which base stations it should measure.
- If the LMU measures signals from BTSs from other time slots than 0 or 4, it must be informed about the burst length scheme used by BTSs.

The Radio Interface Timing measurement response from a LMU to the SMLC contains:

- Location Area Code and Cell Identity of the serving base station.
- If the LMU can perform ATD measurements, and it is told to do them, the ATD measurement of the serving BTS is reported (i.e. time stamp for the reception of the burst from the serving BTS referred to the common reference clock).
- Time slot number of the burst(s) measured from the serving BTS.
- Frame number of the (last) burst measured from the serving BTS.
- For each measured neighbor BTS its identity as Location Area Code and Cell Identity or BSIC & carrier.
- For each measured neighbor BTS the possible ATD measurement is reported. This can be expressed relative to the ATD value of the serving BTS.
- If the LMU does not perform ATD measurements, for each measured neighbor BTS, Observed Time Difference value between the receptions of signals from the serving and the neighbor BTS is reported.
- For each measured neighbor BTS the time slot number of its burst(s).
- For each measured neighbor BTS the (last) frame number of its burst.
- For each measured BTS the quality of measurements. Also the RX level can be reported.

7.8 TA based Positioning

7.1.8.1 Definition of TA states

7.1.1.8.1.1 MS in IDLE State

In IDLE state the GSM MS may be paged or may request an originating (e.g. emergency) call. The paging response message or CM Service Request, in each case respectively, received in COMPLETE_LAYER_3 message mayshall contain location information that includes the TA value. If available, Tthe TA value and other location information shall then be provided to the SMLC by the requesting VMSC or BSC along with the current serving cell ID in the BSSMAP-LE Perform Location request (see section 76.4). This enables TA based positioning in the SMLC without any further interactions.

7.1.2.8.1.2 MS in DEDICATED State

In DEDICATED state the SMLC shall send a BSSLAP TA_REQUEST to request the TA value from the serving BSC. The BSC shall respond with a TA_RESPONSE carrying the TA value. The associated procedure is described in sections 78.2 and 8.3.

7.2.8.2 TA Positioning Procedure for an NSS based SMLCMS in Dedicated State

The TA positioning procedure ifor an NSS based SMLCn dedicated state makes use of the generic SMLC to BSC Information transfer procedure defined in section 76.8.1.

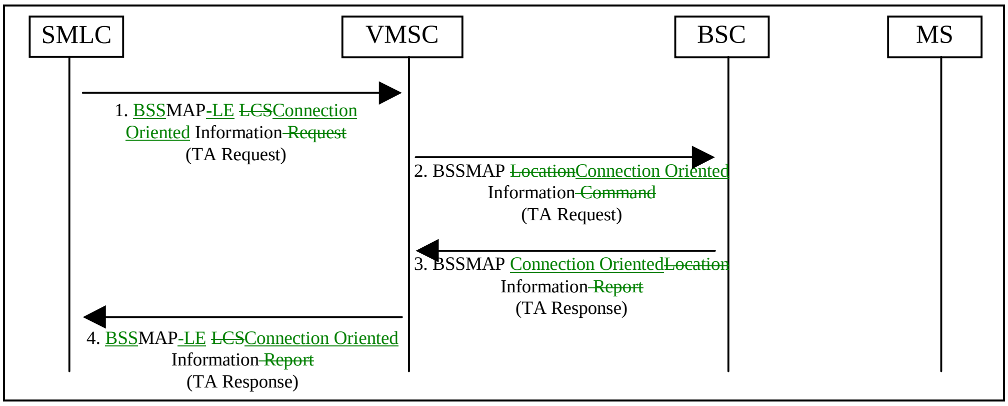


Figure 20 TA Positioning Procedure for an NSS based SMLCfor MS in Dedicated State

(1) The SMLC sends a BSSMAP-LE LCSConnection Oriented Information messageRequest to the visited MSC serving a particular target MS. The BSSLAP APDUlocation information parameter in this message contains a TA Request.
(2) The VMSC transfers the BSSMAP messageTA Request received in step 1 to the serving BSC for the target MS inside a BSSMAP Location Command.
(3) The BSC returns the current TA value and current serving cell for the target MS to the VMSC in a TA response contained within a BSSMAP Connection Oriented Information messageLocation Report. The TA response may also include the latest measurement results received from the target MS for the serving and neighboring cellsalso indicates whether a handover is currently ongoing for the target MS.
(4) The VMSC forwards the BSSMAP-LE messageTA response received in step 3 to the SMLC inside a MAP LCS Information Report. The SMLC then derives a location estimate for the target MS based on the received serving cell ID, and TA value and other measurement results if included.

8.3.8.3 TA Positioning Procedure for a BSS based SMLC

The TA positioning procedure for a BSS based SMLC makes use of the generic SMLC to BSC Information transfer procedure defined in section 7.

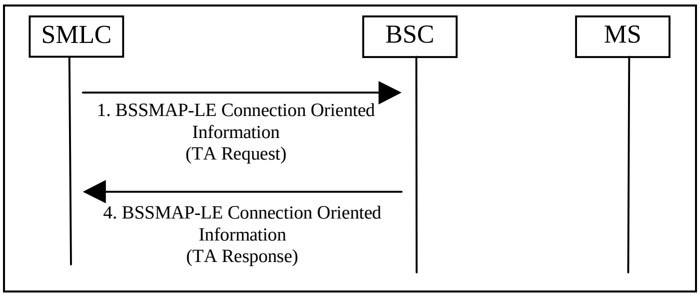


Figure 20 TA Positioning Procedure for a BSS based SMLC

(1) The SMLC sends a BSSMAP-LE Connection Oriented Information message to the BSC serving a particular target MS. The BSSLAP APDU parameter in this message contains a TA Request.

(2) The BSC returns the current TA value and current serving cell for the target MS to the SMLC in a TA response contained within a BSSMAP-LE Connection Oriented Information message. The TA response may also include the latest measurement results received from the target MS for the serving and neighboring cells. The SMLC then derives a location estimate for the target MS based on the received serving cell ID, TA value and other measurement results if included.

~~8.4.~~8.4 Unsuccessful TA positioning procedure in BSC

There are three messages defined ~~in GSM 8.71 specification~~ to handle error scenarios during positioning procedure in BSC. The messages are 1) Reject, 2) Abort and 3) Reset . Please refer to GSM 8.71 for details.

After receiving the BSSLAP TA Request~~"BSSMAP location information command"~~ in BSC (message 2 in section 8.2 and message 1 in section 8.3), a~~A~~ Reject will be sent with proper cause value from BSC to SMLC in "BSSMAP Location Information Report" if TA positioning can-not be performed in BSC at that time for reasons other than handover or another ongoing RR management procedure ~~(e.g Ongoing HO etc.)~~.

Between messages 2 and 3 (in section 8.2) and between messages 1 and 2 in section 8.3, an Abort or Reset is possible if the TA positioning can-not be done in BSC during that time. Reset is sent to SMLC to indicate when the positioning needs to be restarted after temporary interruption due to ~~e.g~~ intra BSC HO or other intra-BSC RR management. Abort is used to indicate to SMLC the failure of the current TA positioning attempt (e.g. due to inter-BSC handover) and allowing a new one from application level.

~~8.~~9. TOA based positioning

~~8.1.Positioning Call Set-up, Positioning Call Deactivation and Positioning Functions~~

~~The Positioning Call Set-Up and Positioning Call Deactivation functions are only meaningful at the NSS level and do not directly involve the BSS.~~

~~Upon receiving a MAP Perform Location message from the VMSC, the SMLC will perform a positioning call set-up for an idle mobile prior to sending the MAP LCS Information Request message to BSS through VMSC.~~

After receiving the 'BSSMAP-LE Connection Oriented ~~Location~~ Information (TOA Request)~~Command~~' from VMSC/SMLC, the BSC shall initiate procedures for position the MS with TOA positioning method.

~~8.2.~~9.1 TOA procedures

8.2.1.9.1.1 Successful TOA Positioning Procedure for NSS based SMLC

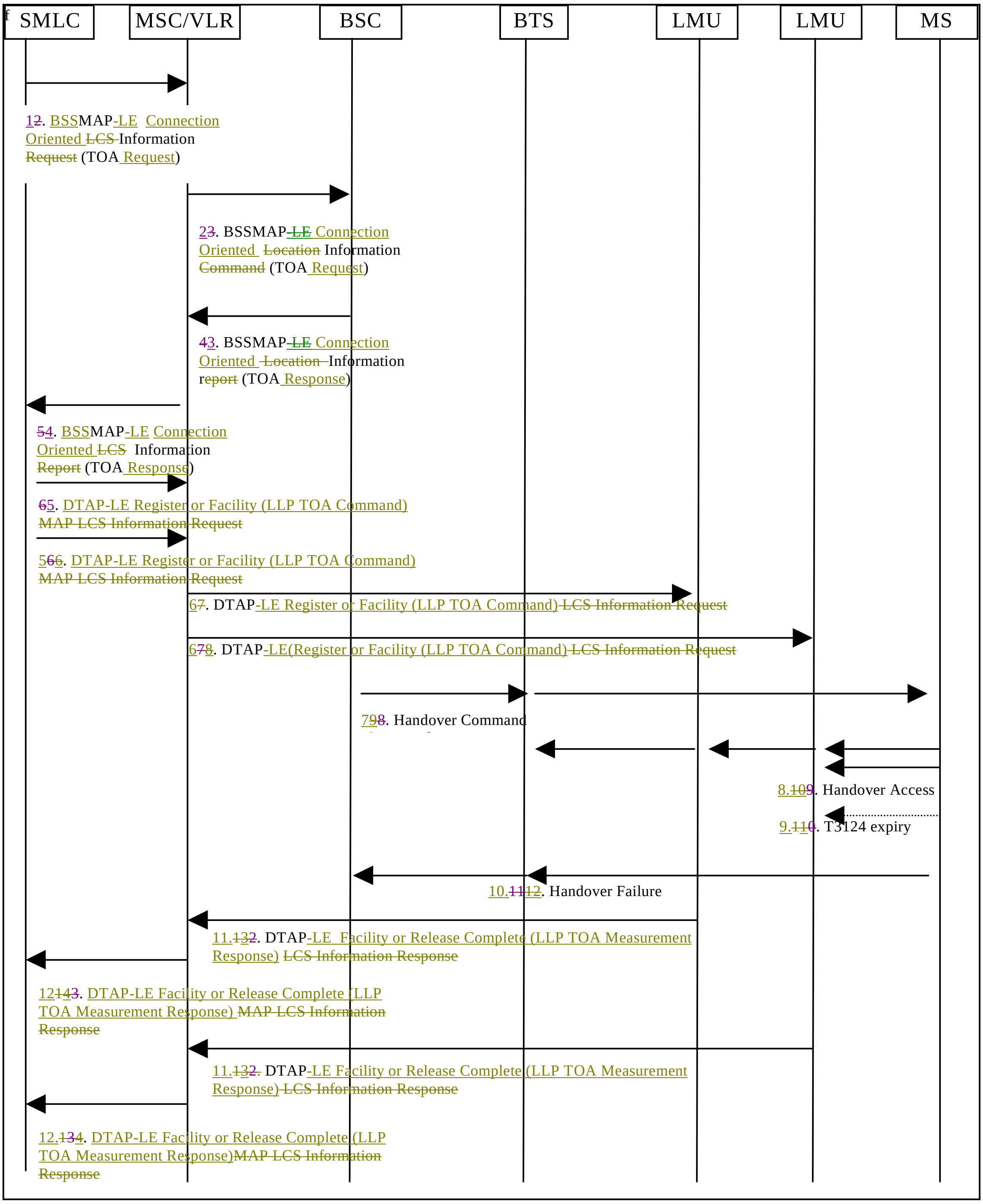


Figure 562924 TOA measurement flows

Positioning Preparations:

1. SMLC, according to section 8.2.1 shall set up a positioning call before sending 'MAP Location Information Command' message for TOA positioning. If the MS is in dedicated mode, this step is skipped.

2.1. VMSC receives a 'BSSMAP-LE Connection Oriented LCS Information (TOA Request)' message from SMLC, which contains the BSC delta timer value and an indication of the preferred type of handover (intra-cell to same channel, intra-cell to new channel or inter-cell). The message also contains the cell ID and TDMA frame number of the serving cell, and depending on the preferred handover type, also contains the cell ID and TDMA frame number for candidate (maximum six) cells for positioning handover.

3.2. The MSC sends the 'BSSMAP-LE Connection Oriented Location Information (TOA Request)Command' message to BSC with the same information received in step 12.

4.3. The BSC specifies the physical channel information (frequencies, hopping sequence, channel type, time slot for access burst etc.), cell ID, TA, measurement report, MS output power, and handover reference number in the 'BSSMAP-LE Connection Oriented Location Information (TOA Response)Report' message to the VMSC. The BSC also starts the delta timer.

Note: If the BSC selects to use a different channel, this channel is reserved internally within the BSC, i.e. no additional signaling or delay is required. Based on the request information from SMLC, the BSC can choose between requesting an intra-cell handover (to same channel or to a new channel) or an inter-cell handover. If BSC decides to make an inter-cell handover the BSC selects a neighbor cell based on the measurement reports received from the MS (only neighbors for which the MS has been able to decode BSIC are possible to specify since the MS needs to know the timing of the target base station).

5.4. The VMSC forwards the information received from BSC (in 4) to the SMLC in 'BSSMAP-LE Connection Oriented LCS Information (TOA Response)Report' message. SMLC uses this information for the configuration of the LMUs.

5. The SMLC selects which LMUs should measure and sends 'DTAPBSSMAP-LE Register or Facility (LLP TOA Command)'LCS Information Request messages for each of these LMUs to the MSC according to the procedure defined in section 7.15.2. 7.8.1.1. Each DTAP-LELCS Information Request message is targeted to one LMU and specifies Radio Frequency List, Hopping Sequence Information, HO reference number, BSIC, Starting Time, Measurement Options, Starting Time Uncertainty, GPS Time Stamping Request.

6. The MSC sends the converts the BSSMAP-LE message from the SMLC into a DTAP message, which reaches the LMUs over the air interface. It has been assumed here that the DTAP connection is already established at this point (refer to section 1.1.11.1.17.11.4 7.8.1.1).

Positioning Establishment:

8.7. At expiration of the delta timer (note 1), the mobile is instructed to perform non-synchronized handover from the current radio channel (e.g. SDCCH or TCH) to a specified traffic channel with HANDOVER COMMAND message. A TDMA frame number at which the sending of ACCESS burst should begin is specified.

8. The MS starts sending the access burst in HANDOVER ACCESS message. At the same time, configured LMUs measure the Time of Arrival of access bursts.

10.9. The MS continues to send the access bursts until the timer T3124 expires when the MS returns to the old channel.

11.10. The MS sends the HANDOVER FAILURE message to the BSC.

12.11. LMUs report their measurement results in a 'DTAP-LE Facility or Release Complete (LLP TOA Measurement Response)' LCS Information Response message to the VMSC.

13.12. The measurement results will be forwarded to the SMLC as a 'DTAPBSSMAP-LE Facility or Release Complete (LLP TOA Measurement Response)' LCS Information Report message with measured TOA, TOA quality estimate, and Used Time Stamping. SMLC shall keep track of the number of expected measurement results from LMUs in the network. If a location estimate satisfying the requested QoS was not successfully obtained, the SMLC may initiate another TOA location attempt by restarting the TOA procedure at step 1.

14.If a location estimate satisfying the requested QoS was not successfully obtained, the SMLC may initiate another TOA location attempt by restarting the TOA procedure at step 1. Otherwise, the SMLC will send an acknowledgement to the initial Location Request from the MSC containing the location estimate of the mobile station being positioned.

15.13. The returned location result from the SMLC shall trigger the MSC to start the RR Connection Release process if the MS was initially idle (see 9.2.3.3).

Note 1: BSC starts the delta timer when received from the MSC in (2). The purpose of this timer is to allow enough time for MLC to initialize and configure all the LMUs for the TOA measurement. This timer value should be long enough for this task. When the BSC timer runs out, the BSC starts the handover process (step 7 10).

Note 2: After a radiotraffic channel is allocated to the MS to be positioned, the MS starts sending measurement reports to the serving BTS. Based on these measurement reports the BSC would normally order handovers when considered necessary. If a radio related handover would take place between message 12 and 79, this would invalidate the information sent to the LMUs and positioning would fail. After the initialization of the delta timer in the BSC (step 35), the BSC shall cancel the ongoing positioning if a radio related handover has been requested. On the other hand, the BSC shall never allow any radio-related handover during steps 7 to 10 and 13 (Is it 13 or 16?).

9.2.2.9.1.2 Successful TOA Positioning Procedure for BSS based SMLC

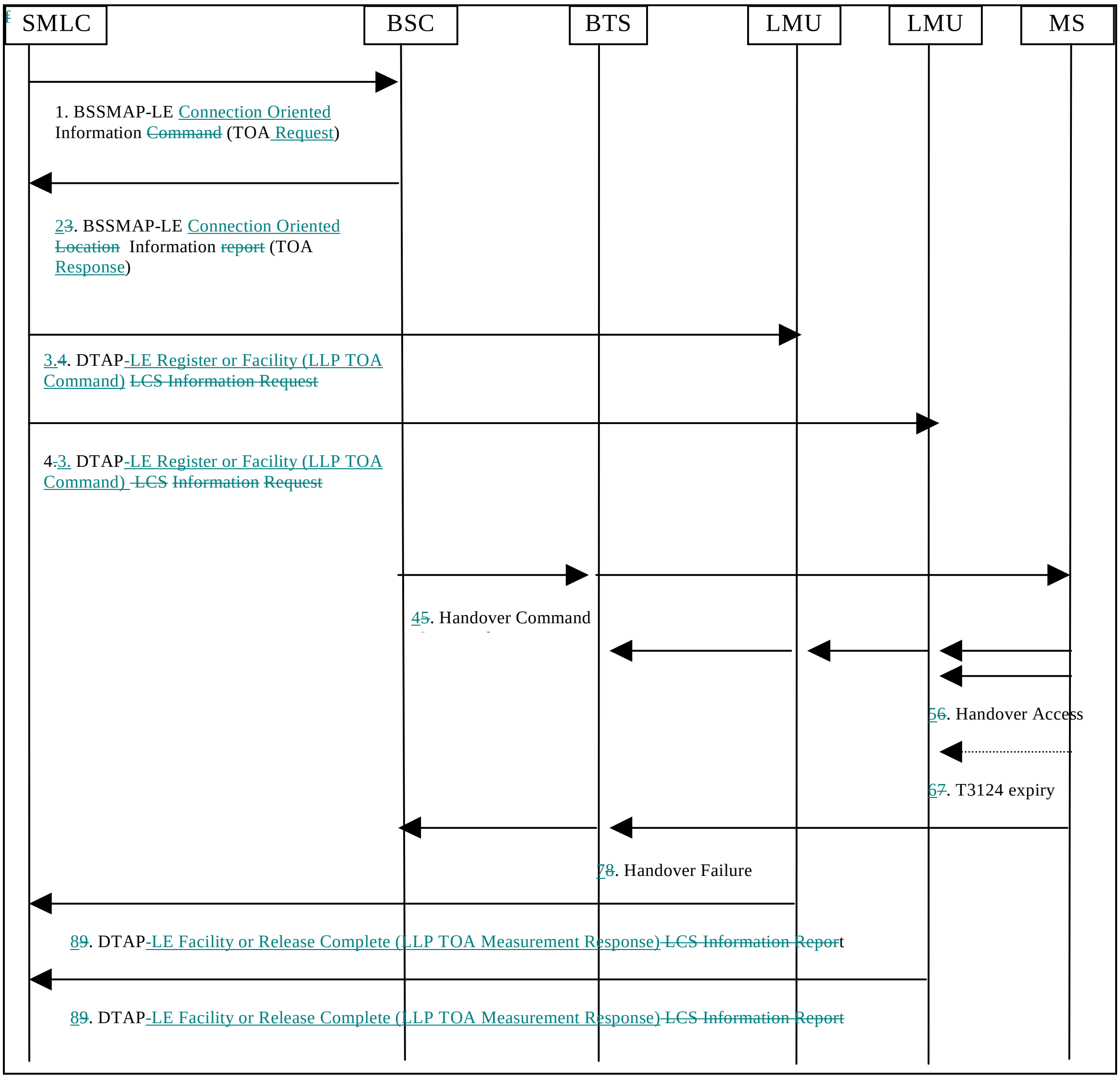


Figure 26 TOA measurement flows for BSS based SMLC

Positioning Preparations:

1. SMLC, according to section 9.2.3.1 can optionally set up a positioning call before sending 'BSSMAP-LE Location Information Command' message for TOA positioning. It is possible to do positioning HO from SDCCH. Hoever, it is required to hold the SDCCH for a longer time in that case. If the MS is in dedicated mode, this step is skipped completely.

12. BSC receives a 'BSSMAP-LE Connection Oriented Information (TOA Command)LCS Information Command' message from SMLC, which contains the BSC delta timer value and an indication of the preferred type of handover (intra-cell to same channel, intra-cell to new channel or inter-cell). The message also contains the cell ID and TDMA frame number of the serving cell, and depending on the preferred handover type, also contains the cell ID and TDMA frame number for candidate (maximum six) cells for positioning handover.

3.2.The BSC specifies the physical channel information (frequencies, hopping sequence, channel type, time slot for access burst etc.), cell ID, TA, measurement report, MS output power, and handover reference number in the 'BSSMAP-LE

Connection Oriented Information (TOA Response)Location Information Report' message to the SMLCC. The BSC also starts the delta timer. SMLC uses this information for the configuration of the LMUs

Note: If the BSC selects to use a different channel, this channel is reserved internally within the BSC, i.e. no additional signaling or delay is required. Based on the request information from SMLC, the BSC can choose between requesting an intra-cell handover (to same channel or to a new channel) or an inter-cell handover. If BSC decides to make an inter-cell handover the BSC selects a neighbor cell based on the measurement reports received from the MS (only neighbors for which the MS has been able to decode BSIC are possible to specify since the MS needs to know the timing of the target base station).

4.3. The SMLC selects which LMUs should measure and sends 'DTAP-LE Resister or Facility (LLP TOA Command)' LCS Information Request messages for each of these LMUs according to the procedure defined in section 1.1.11.1.17.11.4. 7.8.4.1-Each LCS Information Request message is targeted to one LMU and specifies Radio Frequency List, Hopping Sequence Information, HO reference number, BSIC, Starting Time, Measurement Options, Starting Time Uncertainty, GPS Time Stamping Request. It has been assumed here that the DTAP connection is already established at this point (refer to section 1.1.11.1.17.11.4 7.8.4.1).

Positioning Establishment:

5.4. At expiration of the delta timer (note 1), the mobile is instructed to perform non-synchronized handover from the current radio channel (e.g. SDCCH or TCH) to a specified traffic channel with HANDOVER COMMAND message. A TDMA frame number at which the sending of ACCESS burst should begin is specified.
6.5. The MS starts sending the access burst in HANDOVER ACCESS message. At the same time, configured LMUs measure the Time of Arrival of access bursts.
7.6. The MS continues to send the access bursts until the timer T3124 expires when the MS returns to the old channel.
8.7. The MS sends the HANDOVER FAILURE message to the BSC.
9.8. The measurement results will be forwarded to the SMLC as a 'DTAP-LE Facility or Release Complete (LLP TOA Measurement Response)' LCS Information Response message with measured TOA, TOA quality estimate, and Used Time Stamping. SMLC shall keep track of the number of expected measurement results from LMUs in the network.
10.If a location estimate satisfying the requested QoS was not successfully obtained, the SMLC may initiate another TOA location attempt by restarting the TOA procedure at step 1. Otherwise, the SMLC will send an acknowledgement to the initial Location Request from the BSC containing the location estimate of the mobile station being positioned.
11.The returned location result from the BSC shall trigger the MSC to start the RR Connection Release process if the MS was initially idle (see 1.1.1.11.1.1.19.2.3.3).

Note 1: BSC starts the delta timer when received from the SMLC in (12). The purpose of this timer is to allow enough time for SMLC to initialize and configure all the LMUs for the TOA measurement. This timer value should be long enough for this task. When the BSC timer runs out, the BSC starts the handover process (step 45).
Note 2: After a radio channel is allocated to the MS to be positioned, the MS starts sending measurement reports to the serving BTS. Based on these measurement reports the BSC would normally order handovers when considered necessary. If a radio related handover would take place between message 1 and 4, this would invalidate the information sent to the LMUs and positioning would fail. After the initialization of the delta timer in the BSC (step 2), the BSC shall cancel the ongoing positioning if a radio related handover has been requested. On the other hand, the BSC shall never allow any radio-related handover during steps 4 to 7.

8.2.1.1 TCH or SDCCH Assignment by the BSCPositioning call set-up
8.2.1.1.1Normal Case
The procedure described here is applicable to assignment of a positioning TCH to support TOA and subsequent reassignment of an SDCCH after TOA is complete.

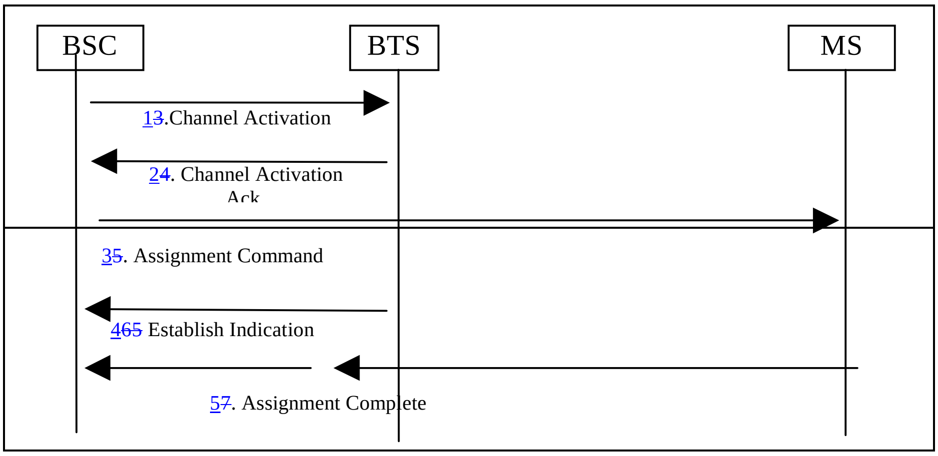


Figure 5858583025 TCH or SDCCH Assignment by the BSCTOA positioning call set-up for normal case

1.SMLC sends 'MAP Assign Traffic Channel' message to VMSC for an MS not allocated with a traffic channel.
2.VMSC sends an ASSIGNMENT REQUEST message to BSC, for the set-up of a traffic channel.
3.The activation of the BTS is ordered by the BSC with CHANNEL ACTIVATION message. The mode of the channel (TCH or SDCCH) is included.
4.The BTS acknowledges the allocation of the newspeech channel by sending CHANNEL ACTIVATION ACKNOWLEDGE message.
5.The BSC then sends an ASSIGNMENT COMMAND message towards the MS, telling the mobile station to switch to the new channel.
6.When the MS has switched to the new channel, the ESTABLISH INDICATION message is sent from the BTS.
7.The MS then sends the ASSIGNMENT COMPLETE message to the BSCVMSC indicating that the assignedtraffic channel is up and running.
8.VMSC sends 'MAP Assign Traffic Channel Ack' message to SMLC.
8.2.1.1.2Directed Retry
If radio related conditions require the assignment of a new serving cell during a positioning call setup, the directed retry handover procedure defined in GSM 03.09 shall be used instead of the normal procedure described previously to assign a traffic channel. The VMSC shall then indicate a failure of the ordered TOA procedure to the SMLC and include within the failure indication the reason for failure (directed retry) and the identity of the new serving cell. The SMLC may then order a new TOA location attempt based on the new cell.
8.2.1.2RR Connection Release for TOA Positioning for an Idle MS
Once the positioning process has completed for an idle MS, the MS must go back to idle mode and the resources must be released. The method for releasing of RR connections is the same as in current GSM standard.

Editorial Note: TOA exception procedures are not updated here since changes will depend on whether the new proposals for generic exception procedures (section 7) are accepted which variant of TOA handover is agreed. When these issues are settled, the following section can be updated.

9.2.2.9.1.3 Unsuccessful TOA positioning procedure in BSC

There are three messages defined in GSM 8.71 specification to handle error scenarios during positioning procedure in BSC. The messages are 1) Reject, 2) Abort and 3) Reset . Please refer to GSM 8.71 for details.

After receiving the BSSLAP TOA Command"BSSMAP location information command" in BSC (message 23 in section 9.1.18.2.1 and message 1 in section 9.1.2), aA Reject will be sent with proper cause value from BSC to SMLC in "BSSMAP Location Information Report" if TOA positioning can-not be performed in BSC at that time for reasons other than handover or another ongoing RR management procedure(e.g Radio Related HO, Congestion etc.).

Between messages 34 and 78 in section 9.1.1 and between messages 2 and 4 in section 9.1.2 (i.e the duration of delta timer in the BSC section 8.2.1), an Abort or Reset is possible if the TOA positioning can not be done in BSC during that time. Reset is sent to SMLC to indicate when the positioning needs to be restarted after temporary interruption due to ane.g intra BSC HO or other intra-BSC RR management procedure. If the Handover Complete or Handover Failure is not received before the delta timer expires, Abort maywill be sent at the expiration of delta timer from BSC to SMLC. Abort is used to indicate to SMLC the failure of the current TOA positioning attempt (e.g. due to inter-BSC handover) and allowing a new one from application level.

10. E-OTD and GPS Positioning Procedures

10.1 Positioning for BSS based SMLC

This signaling flow is generic for all MS based or assisted location methods (MS Based E-OTD, MS Assisted E-OTD, GPS and Assisted GPS).

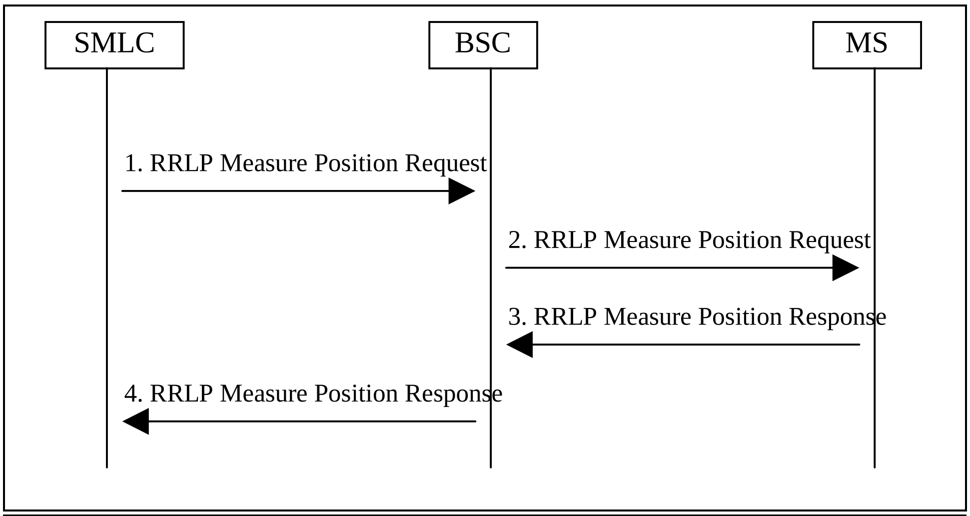


Figure 37 E-OTD /GPS Positioning Flow

1. The SMLC determines possible assistance data and sends RRLP MEASURE POSITION request to the BSC.
2. The BSC forwards the positioning request including the QoS and any assistance data to the MS in a RRLP MEASURE POSITION request.
3. Provided that location request is allowed from a privacy perspective, the MS performs the requested E-OTD or GPS measurements. If the MS is able to calculate its own location and this is required, the MS computes a location estimate based on E-OTD or GPS measurements. Any data necessary to perform these operations will either be provided in the RRLP MEASURE POSITION request or available from broadcast sources. The resulting E-OTD or GPS measurements or E-OTD or GPS location estimate are returned to the BSC in a RRLP MEASURE POSITION response. If the MS was unable to perform the necessary measurements, or compute a location, a failure indication is returned instead.
4. BSC forwards the RRLP MEASURE POSITION response to SMLC.

10.2 Positioning for NSS based SMLC

This signaling flow is generic for all MS based or assisted location methods (MS Based E-OTD, MS Assisted E-OTD, GPS and Assisted GPS).

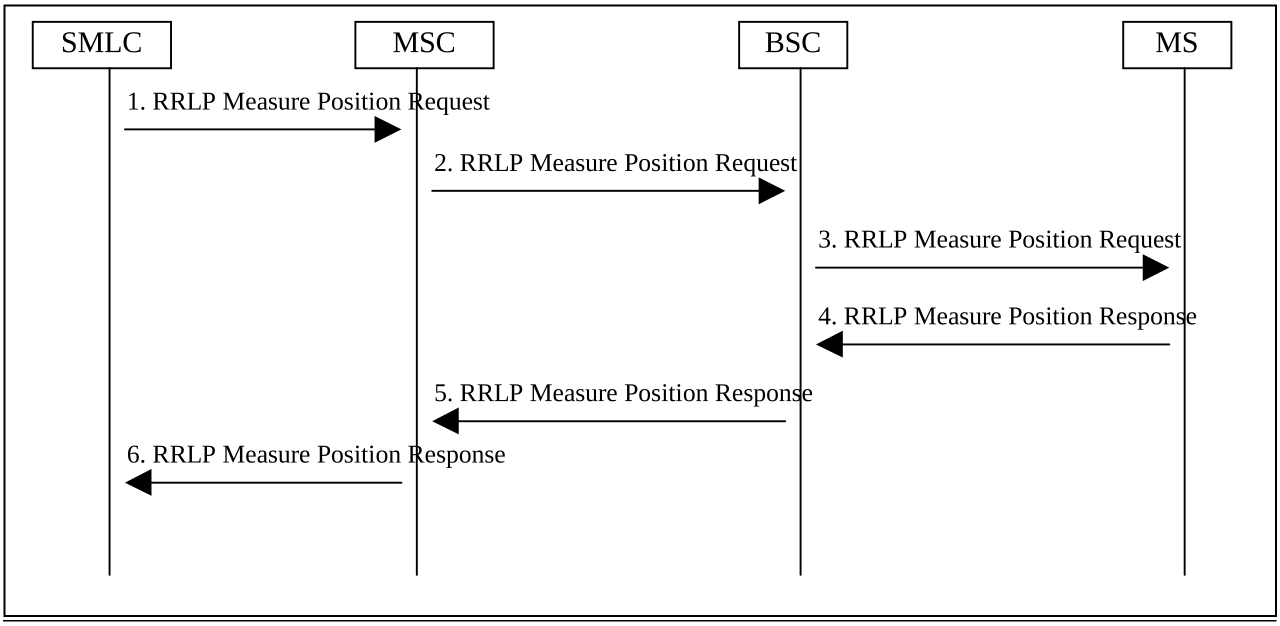


Figure 38 E-OTD /GPS Positioning Flow

1. The SMLC determines possible assistance data and sends RRLP MEASURE POSITION request to MSC.
2. The MSC forwards the RRLP MEASURE POSITION request to the BSC.
3. The BSC sends the positioning request including the QoS and any assistance data to the MS in a RRLP MEASURE POSITION request.
4. Provided location privacy is not enabled in the MS, or enabled but overridden to obtain location for an emergency call, the MS performs the requested E-OTD or GPS measurements. If the MS is able to calculate its own location and this is required, the MS computes an E-OTD or GPS location estimate. Any data necessary to perform these operations will be either provided in the RRLP MEASURE POSITOIN request or available from broadcast sources. The resulting E-OTD or GPS measurements or E-OTD or GPS location estimate are returned to the BSC in a RRLP MEASURE POSITION response. If the MS was unable to perform the necessary measurements, or compute a location, a failure indication is returned instead.
5. BSC sends measurement results in the MEASURE POSITION response within BSSMAP Location Information Report message to MSC.
6. MSC forwards the measurement results in the MEASURE POSITION response within LCS Information Report message to SMLC.

10.3 Assistance Data Delivery from BSS based SMLC

This signaling flow is generic for all MS based location methods (MS Based and Assisted E-OTD and Network Based and Assisted GPS).

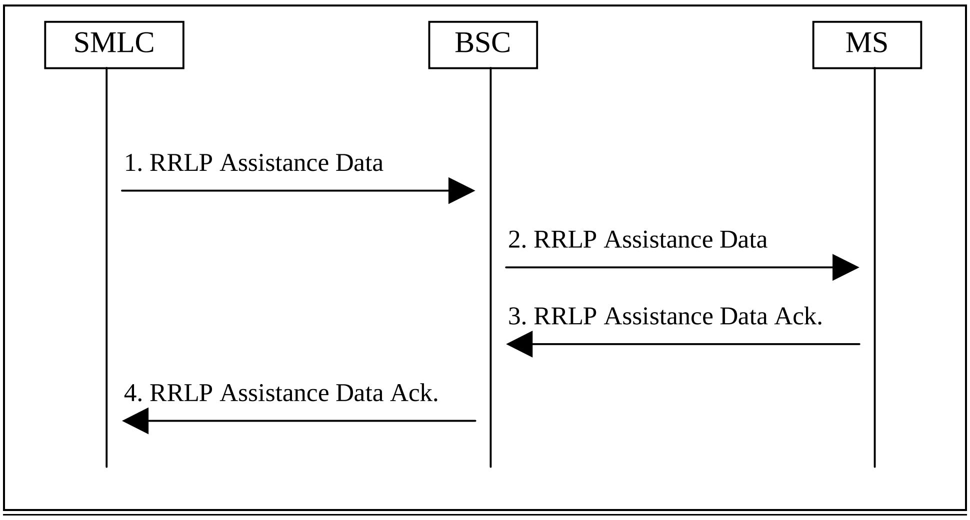


Figure 39 E-OTD or GPS Assistance Data Delivery Flow with BSS based SMLC

(1) The SMLC determines possible assistance data and sends it in the RRLP ASSISTANCE DATA message to the BSC.
(2) The BSC forwards the assistance data to the MS in a RRLP ASSISTANCE DATA message. If the assistance data does not fit to one message, the messages 1 and 2 can be repeated.
(3) The MS acknowledges the reception of complete assistance data to the BSC with a RRLP ASSISTANCE DATA Ack.
(4) The BSC forwards the RRLP ASSISTANCE DATA Ack message to the SMLC.

10.4 Assistance Data Delivery from NSS based SMLC

This signaling flow is generic for all MS based location methods (MS Based and Assisted E-OTD and Network Based and Assisted GPS).

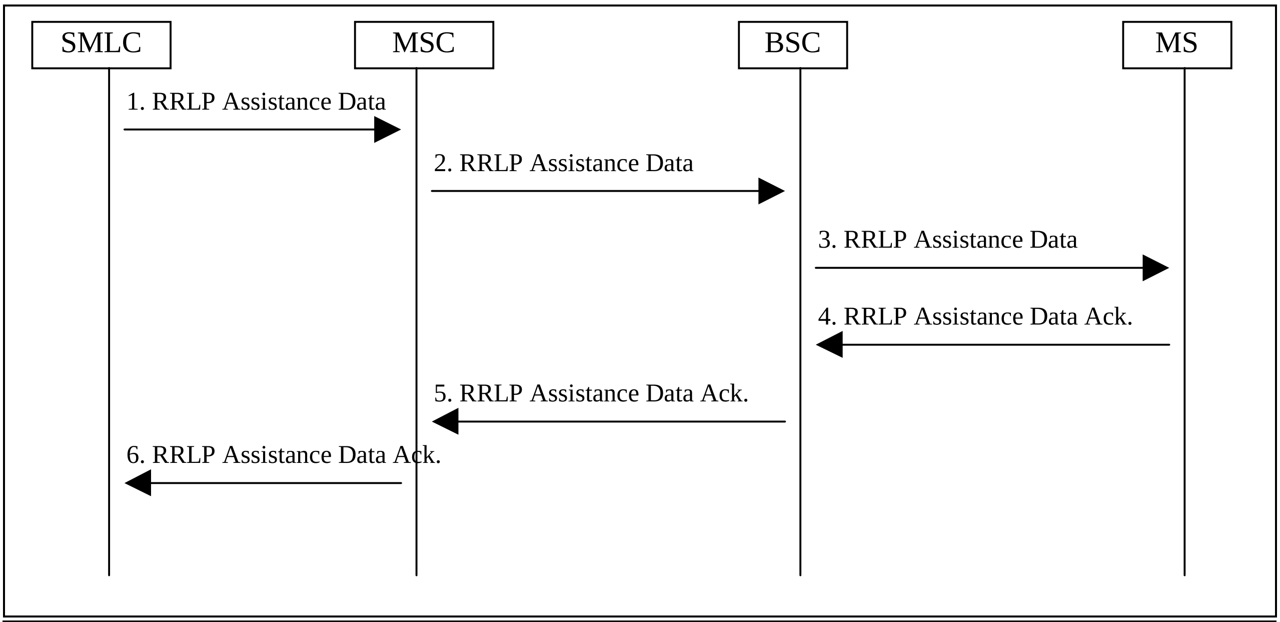


Figure 40. E-OTD or GPS Assistance Data Delivery Flow with NSS based SMLC

(1) The SMLC determines possible assistance data and sends the RRLP ASSISTANCE DATA message to the MSC.
(2) The MSC forwards the RRLP ASSISTANCE DATA message to the BSC.

(3) The BSC sends the assistance data to the MS in a RRLP ASSISTANCE DATA message. If the assistance data does not fit to one message, the messages 1, 2 and 3 can be repeated.
(4) The MS acknowledges the reception of complete assistance data to the BSC in a RRLP ASSISTANCE DATA Ack.
(5) The BSC sends the RRLP ASSISTANCE DATA Ack to the MSC.
(6) The MSC forwards the RRLP ASSISTANCE DATA Ack to the SMLC.

10.5.10.5 Error Handling for E-OTD and GPS

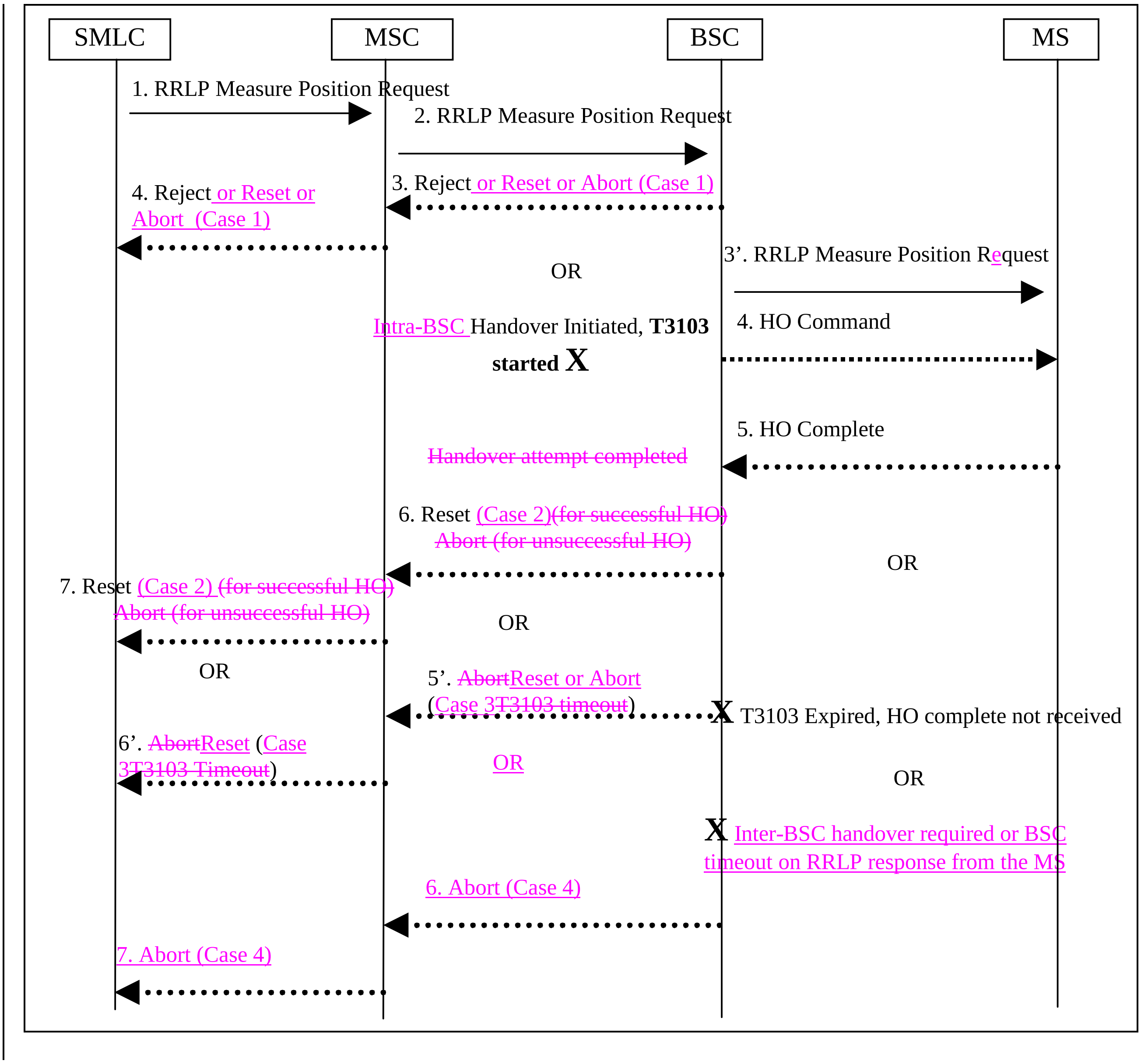
Case 1: When the RRLP positioning request comes to BSC for E-OTD and GPS, The BSC will send a BSSLAP reject message to SMLC if the positioning cannot be supported in the BSC for reasons other thanthere is an ongoing intra BSC or inter BSC handover or other ongoing RR management procedure. For an ongoing intra BSC HO or other RR management procedure, the BSC shall return a BSSLAP Reset when the handover or RR management procedure is complete. tThe SMLC may then start the positioning request (if there is time) again when the HO completes. For ongoing inter-BSC HO, the SMLC shall return a BSSLAP Abort. The positioning request may then restart from either the LCS Client orapplication level VMSC).

Case 2: When the RRLP positioning request comes to BSC from SMLC, BSC sends “RRLP measure position request” to MS for performing E-OTD or GPS measurements or E-OTD or GPS location estimate if there is no ongoing HO or other RR management procedure at that point. NowIf an intra-BSC HO or other RR management procedure is initiated in BSC, and the BSC sends the HO or other RR management command to MS. A timer, T3103 will then be started in BSC, the duration of which is network dependent, but typically 6 (six) seconds. Upon receiving the HO of other RR management command, the MS will stop positioning and start on handover or other RR management procedure, since thisHO has highermore priority thanover positioning. The MS will then send the HO complete or other RR management response message to BSC. WhenIf this HO complete message is received before the expiration of BSC timerT3103, a BSSLAP Reset or Abort message will be sent to SMLC from BSC. A Reset message will be sent if the HO is successful and it is an intra BSC HO. An Abort message will be sent if the HO failed or if it is an inter BSC HO. The Reset will tell SMLC to start another positioning request if there is enough time. The Abort will tell SMLC to start positioning request from the application level.

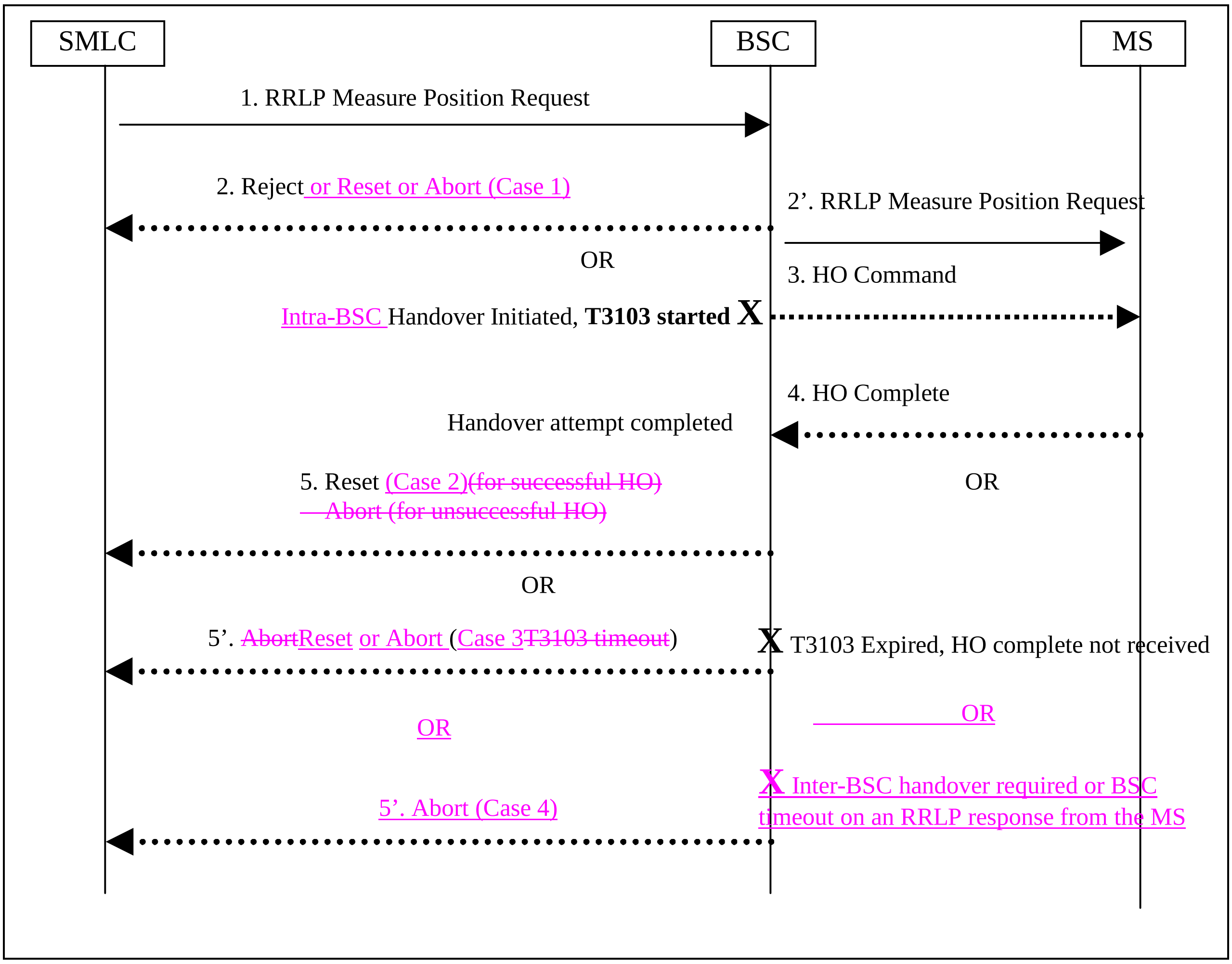
Case 3: During intra-BSC HO or other intra-BSC RR management procedure, if a HO complete or RR management procedure completion was not received in BSC and the correspondingT3103 timer expired. In this case an reset or abortabort message will be sent to SMLC indicating MS timeout.and tThe positioning maywill then restart from either the SMLC if a reset was sent or from the LCS Client or VMSC if an abort was sentapplication level.

Case 4: If an inter-BSC (or inter-MSC) handover is needed during positioning or if the BSC times out on an RRLP measure position response from the target MS, the BSC shall send a BSSLAP Abort to the SMLC. The positioning attempt may then be restarted from either the LCS Client or VMSC.

10.5.1.10.5.1 NSS based SMLC


SMLC
MSC
BSC
MS
1. RRLP Measure Position Request
2. RRLP Measure Position Request
3. Reject or Reset or Abort (Case 1)
4. Reject or Reset or Abort (Case 1)
OR
3'. RRLP Measure Position Request
Intra-BSC Handover Initiated, T3103 started
4. HO Command
5. HO Complete
Handover attempt completed
6. Reset (Case 2)(for successful HO) Abort (for unsuccessful HO)
OR
7. Reset (Case 2) (for successful HO) Abort (for unsuccessful HO)
OR
OR
5'. AbortReset or Abort (Case 3T3103 timeout)
T3103 Expired, HO complete not received
6'. AbortReset (Case 3T3103 Timeout)
OR
OR
Inter-BSC handover required or BSC timeout on RRLP response from the MS
6. Abort (Case 4)
7. Abort (Case 4)

10.5.2.10.5.2 BSS based SMLC



10.6 Broadcast OF ASSISTANCE DATA

In MS Based E-OTD and Network Assisted GPS system, where the location calculation is done in the mobile station, there is a need for assistance data to be transferredbroadcast to the MS. The assistance data to be broadcast for MS Based E-OTD contains the Real Time Difference (RTD) values (in case of a non-synchronized network) and Base Transceiver Station (BTS) coordinates. In addition, the broadcast data contains other information simplifying the E-OTD measurements. In GPS transmittingthe broadcast of differential corrections to the MS increases the location accuracy.

The E-OTD assistance data to be broadcast is in compressed format where the redundant information is not included. The MS is capable to reconstruct the E-OTD assistance data using the message header information. The length of the message is depending on how many neighbors are included in the E-OTD assistance data as well as whether the redundant information can be removed from the message. The typical size of one broadcast message will be less than 82 octets. Part of the broadcast message (serving and neighbor basestation coordinates) may be ciphered.

The GPS assistance data to be broadcast consists of GPS differential corrections. The amount of data is similar to the E-OTD assistance data, the maximum amount of satellites 12 which can be encapsulated into 71 octets GPS assistance data message. The message contains header information and the differential corrections. Part of the broadcast message (GPS differential corrections) may be ciphered.

The contents of the broadcast message for the E-OTD and GPS assistance data is described in GTS 04.35.

The broadcast channel which is used to broadcast the E-OTD and GPS assistance data make use of the existing basic CBCH and SMSCB DRX service.

~~**Editor's note**: more text about the nature of the assistance data, broadcast channel and broadcast frequency will be inserted when these have been agreed.~~

10.6.1 Point-To-Multipoint Assistance Data Broadcast Flow

~~The signaling flow for broadcast messages is presented in the following figure.~~
This signaling flow is generic for all MS based location methods (MS Based E-OTD and Assisted GPS). The E-OTD/GPS Assistance Data Broadcast Message is created in SMLC and the whole message including the ciphered parts and parameters to control the transfer are transferred with below flow from SMLC to MS. SMLC is also responsible for creating SMSCB DRX schedule message to indicate MS when to listen the CBCH channel. Prior receiving the first schedule message MS should read first block of each message lot to be able to receive the LCS Broadcast Data or the schedule message. After receiving the schedule message MS should receive the LCS Broadcast Data messages according the schedule information.

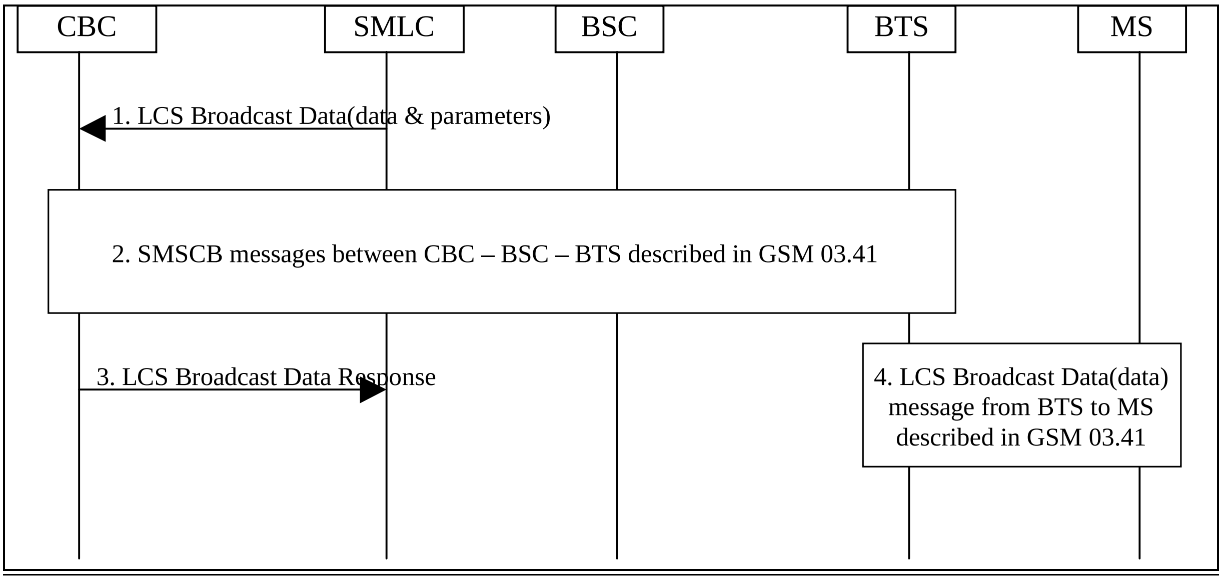


Figure 60 - E-OTD /GPS Broadcast Data Flow

~~**Figure 41. Signaling flow for location information broadcast**~~

1. SMLC sends the complete broadcast message to CBC with LCS Broadcast Data message. This LCS Broadcast Data message contains the data to be broadcasted as well as parameters which indicate to which BTS the broadcast message is targeted~~,~~ and what time the broadcast should happen ~~and the serial number(s) that are used in the SMSCB message~~. LCS Broadcast Data message may also contain the SMSCB scheduling information which is broadcasted to MS in order that MS can utilize the SMSCB DRX feature specified in GSM 04.12 specification. SMSCB DRX operation is required in order that MS performance can be optimized.

2. CBC starts message transfer to BSC and BTS according to GSM 03.41.

3. LCS Broadcast Data Response message from CBC to SMLC is used to indicate that the LCS Broadcast Data has been deliverery request has been fulfilled. This message is not mandatory

4. BTS starts the message transfer to MS according to GSM 03.41.

Implementations that have SMLC and/or CBC integrated into BSC may use other message signalling.

Editor's note: This figure will be added when the broadcasting channel is decided on.

10.6.2 Ciphering

In order for the operators to control the access to the assistance data, parts of the broadcast data may be ciphered. Ciphering is done with a specific key delivered by NW for this purpose. The ciphering key is delivered to themay be requested by MS during a location update (IMSI Attach, Normal or Periodic Location Update) with the generic MO-LR DTAP Location Services Invoke command. . The Follow-On Procedure operation is used to keep the point-to-point connection between MS and NW open after location update. The ciphering key may be GSM PLMN, VLR Area or Location Area specific.

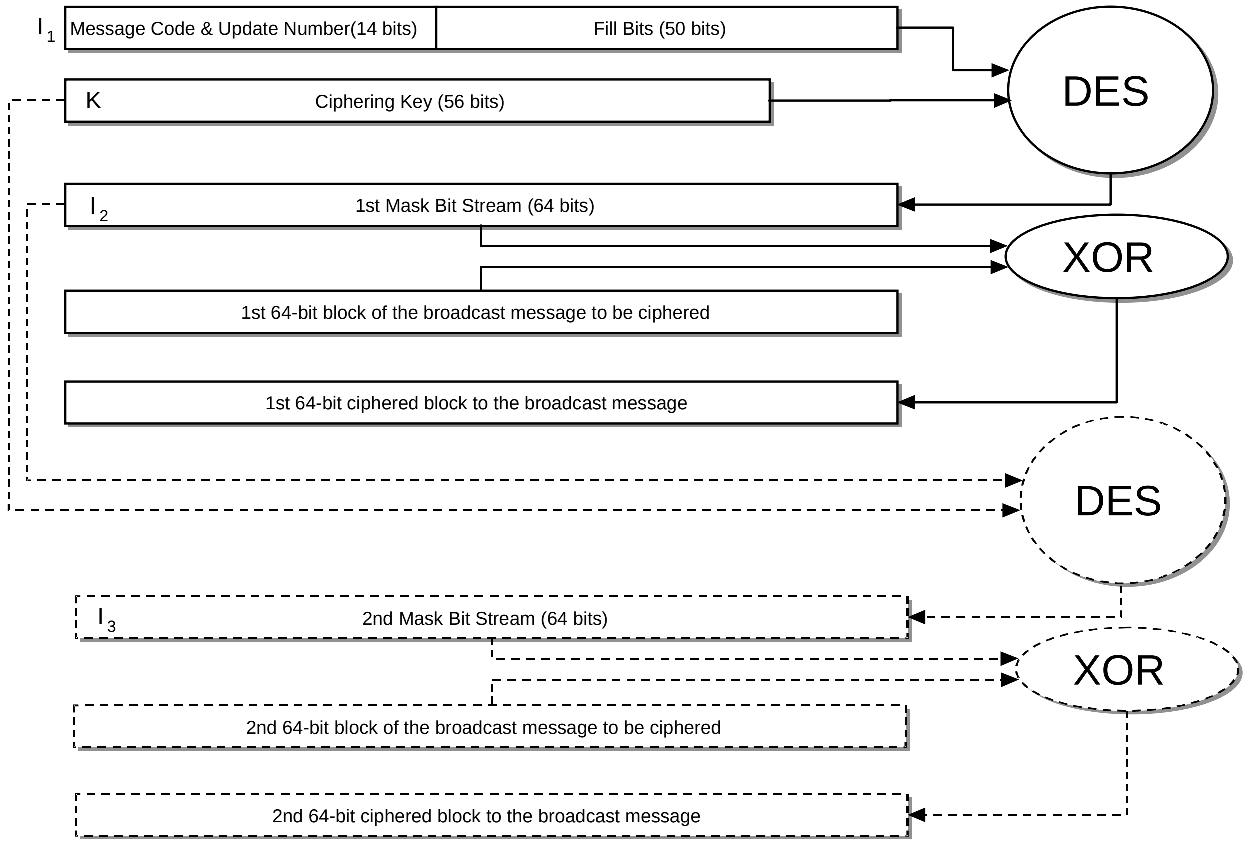
The LCS Broadcast Data, when ciphered, will be partially ciphered according the LCS broadcast message definitions specified in GTS 04.35. The parts that will be ciphered in E-OTD LCS Broadcast Data message are neighbor RTD values, serving and neighbor BTS coordinates. For GPS the differential correction data is ciphered. The ciphering operation will be conducted by SMLC. The MS is capable to decipher the broadcast message (ciphered parts) using the cipher key (56 bits) delivered from NW to MS and SMSCB message's Serial Number's Message Code (10 bits) and Update Number (4 bits) specified in GSM 03.41 and using the Ciphering Serial Number (16 bits) included in the broadcast message.
The ciphering key is centrally administered. *(This sentence can be removed if MO-LR is accepted.)*

10.6.2.1 Algorithm

The algorithm used for ciphering is the standard 56-bit DES algorithm. The deciphering of broadcast messages is done in the ME. The algorithm will utilize the ciphering key delivered during location update with MO-LR. SMLC ciphers the LCS Broadcast Data message (part of message is ciphered) using the ciphering key (56 bits) and SMSCB message serial number Ciphering Serial Number (16 bits) included in broadcast message using 56-bit DES algorithm.
The ciphered part is variable length with one bit resolution. From LCS Broadcast Data message header MS can compute what part of message is ciphered.
Inputs to the 56-bit DES algorithm are the following:

- 56-bit key K (deciphering key) requested with MO-LR
- 164-bit Ciphering Serial Number from broadcast message message number (from SMSCB message's Serial Number's Message Code and Update Number) which is denoted here by IV (initialization vector)
- plaintext bits (the ciphered part of broadcast message)

Encryption is done by producing a mask bit stream which is then added bit-by-bit to the plaintext data (XOR-operation) to obtain the ciphertext data. First IV is concatenated with 0-bits in order to achieve a 64-bit block I_1. This block is then encrypted by the DES algorithm using the key K. Output is a 64-bit block I_2. This constitutes the first 64 bits of the mask bit stream. If the message is longer than 64 bits, then more bits are needed. Those are produced by encrypting I_2 again by the DES algorithm using the key K. Output is a 64-bit block I_3. This constitutes the next 64 bits of the mask bit stream. This iteration is continued until enough bits are produced. The unnecessary bits from the last 64-bit block I_j are discarded. Below figure describes the first two mask bit generations and the two ciphered 64-bit blocks.



Decryption is done similarly. The same mask bit stream is produced. This time the mask stream bits are added bit-by-bit (XORed) to the ciphertext data bits. The result will be the plaintext data.

10.6.2.2 Deciphering key delivery to MS

During a location update, the current and next deciphering keys are delivered to the MS. This allows changing the key with the same interval as the periodic location updates are done, still making sure that the MS always has an updated key. A deciphering key in LCS Broadcast Data message header indicates when the key changes. The MS can detect from the flag change in LCS Broadcast Data header that the use of current cipher key must be changed to the newest key. ~~identifier indicates when the key changes.~~ The following figure describes the deciphering key delivery mechanism.

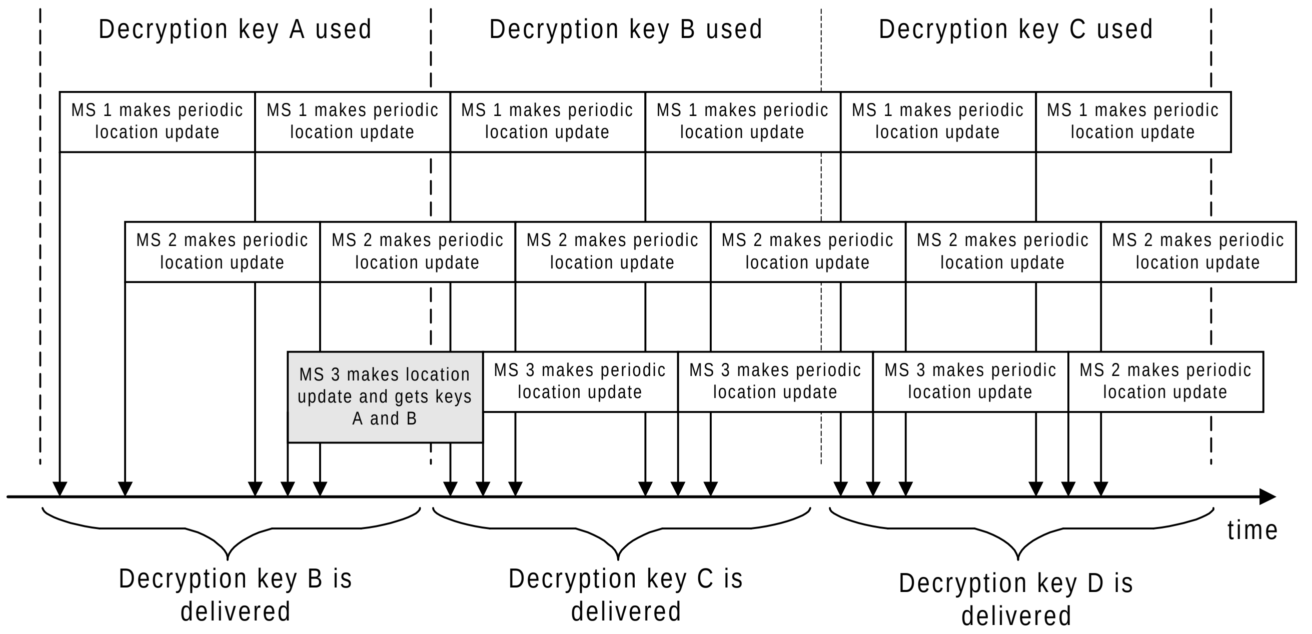


Figure 42. Deciphering key delivery in periodic location updates.

The deciphering key may be requested by MS during the IMSI Attach, Normal Location Update and Periodic Location Update. The MS may request a point-to-point connection to be open after IMSI Attach, Normal Location Update and Periodic Location Update using Follow-On Procedure. The deciphering key request is done using the generic MO-LR DTAP Location Services Invoke command.

~~Deciphering key delivery during location update when changing the VLR area~~

~~***<Nokia now proposes that only MO-LR is used to deliver (e.g. after location update with Follow-On Proceed) the ciphering key to MS. I.e. the signaling flows presented below could be deleted. Only reference to generic MO-LR should be given.>***~~

~~The following figure presents the signaling flow in the case when the deciphering key is delivered to the MS during the location update when changing the VLR area. The ciphering keys to the MS are delivered in a ciphered mode.~~

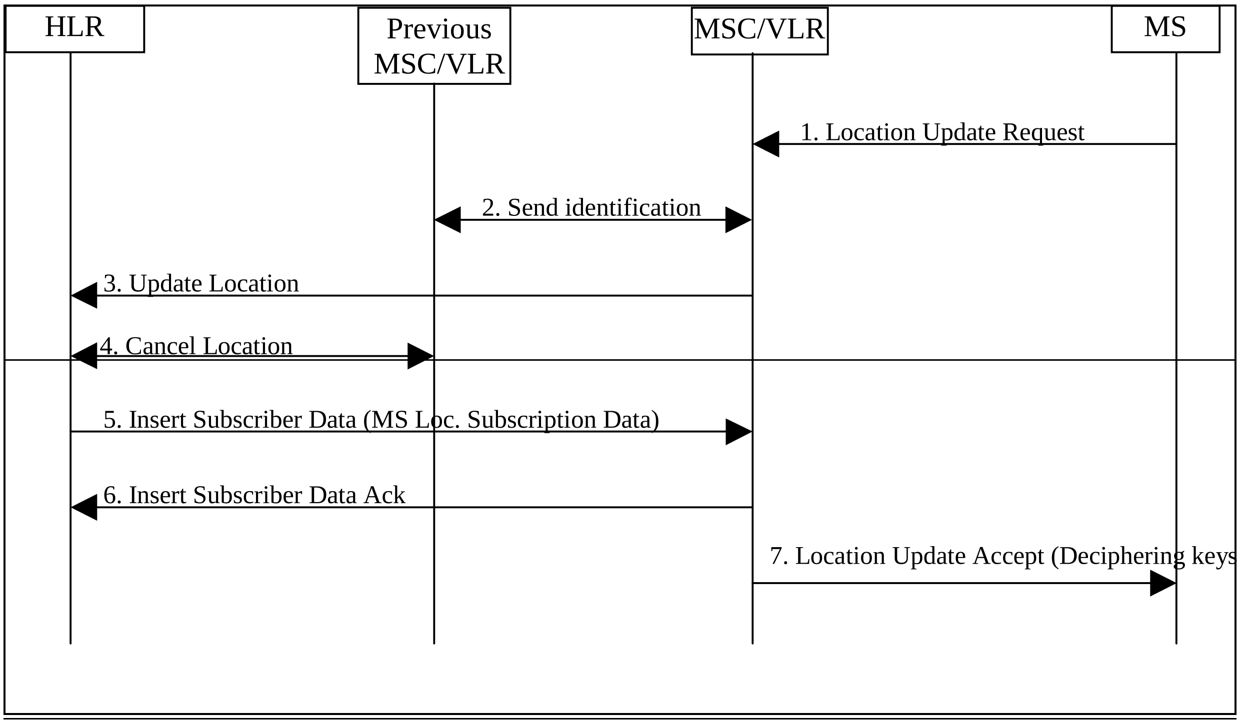


Figure 43. Signaling flow for deciphering key delivery during location update

1. The MS initiates a location update.
2. The MSC/VLR shall ask for the MS information from the previous VLR.
3. The MSC/VLR shall inform the HLR that the VLR area has changed.
4. The HLR shall perform the Cancel Location procedure to the previous VLR.
5. The HLR shall send the subscriber data to the MSC/VLR. The subscriber data contains the information whether the MS based location calculation has been subscribed.
6. The MSC/VLR shall send an acknowledgment to the Insert Subscriber Data message
7. The MSC/VLR shall send an acknowledgment to the location update request. If the MS Location based calculation has been subscribed, the acknowledgment shall contain the current deciphering key for the broadcast location information and the deciphering key for next period.

Deciphering key delivery during the periodic location update or when changing the Location Area

The following figure presents the signaling flow in the case when the deciphering key is delivered to the MS during the location update during the periodic location update or when changing the location area.

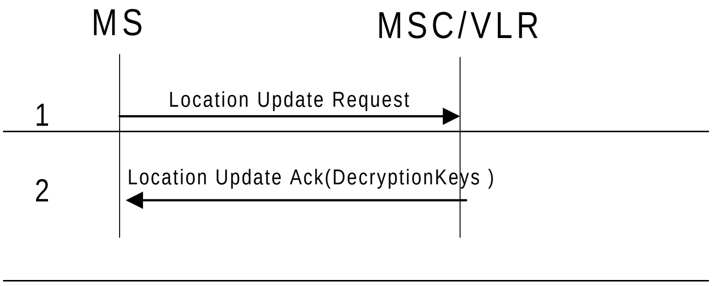


Figure 44. Signaling flow for deciphering key delivery during location update

1. The MS initiates a location update.

The MSC/VLR shall send an acknowledgment to the location update request. If the MS location based calculation has been subscribed, the acknowledgment shall contain the current deciphering key for the broadcast location information and the deciphering key for next period.

9.11. Position calculation functionality

9.1.11.1 TA

For the TA once the cell-ID and TA value has been returned to the MLC, the MLC PCF should map this information into a standardized format suitable for the client. This may infer either just passing the received information in its current format or representing the area in some manner.

9.2.11.2 Time Of Arrival (TOA) Positioning mechanism

For the TOA positioning mechanism once the cell-IDs, TOA values and TOA measurement quality information has been returned to the SMLC, the SMLC PCF should estimate the position of the MS based on this information and MLC prior knowledge of RTDs and BTS LMU co-ordinates. The estimated MS position is then mapped and/or converted into a standardized format suitable for the requesting client.

11.3 Enhanced Observed Time Difference (E-OTD)

For the E-OTD positioning mechanism once the Cell IDs (or possibly in case of neighbor BTSs the Channel and BSIC information), TA value to the serving BTS, E-OTD values and E-OTD measurement quality information have been returned to the MLC, the MLC PCF should estimate the position of the MS based on this information and MLC prior knowledge of RTDs and BTS coordinates. The estimated MS position is then mapped and/or converted into a standardized format suitable for the requesting application.

11.4 Global Positioning System (GPS) positioning mechanism

For the case where the PCF is in the GPS-equipped MS, the MS measures the phases of signals transmitted by the GPS satellites. Subsequently, the MS uses these measurements along with information describing the respective satellite positions to estimate its own position. The MS may choose to use assistance data available from within or outside of the GSM network during measurement and position computation, but this is not mandatory. The MS returns the position estimate to the MLC, along with an estimate of the position accuracy. The estimated MS position is then mapped and/or converted into a standardized format suitable for the requesting application.

For the case where the PCF is in the MLC, the MS measures the phases of signals transmitted by the GPS satellites. The MS may choose to use assistance data available from within or outside of the GSM network to aid the measurement process, but this is not mandatory. The MS returns the measurements and associated quality estimates to the MLC. The MLC uses these results plus the cell-ID (location) of the serving BTS, time-measurement results from the GEMU, and information describing the positions of the satellites measured by the MS to estimate the MS's position. The estimated MS position is then mapped and/or converted into a standardized format suitable for the requesting application.

10.12. Information storage

This section describes information storage structures that are mandatory (M), conditional (C) or optional (O) for LCS, and the recovery and restoration procedures needed to maintain service if inconsistencies in databases occur and for lost or invalid database information.

10.1.12.1 HLR

The HLR holds LCS data for both MS subscribers and LMUs.
10.1.1.LCS Data in the HLR for an MS Subscriber

The IMSI is the primary key for LCS MS subscription data in the HLR. This subscription data may be stored in a Multiple Subscriber Profile (MSP), with the HLR able to hold a number of MSPs per IMSI.

LCS MS subscription data includes a privacy exception list containing the privacy classes for which location of the target MS is permitted. Each privacy class is treated as a distinct supplementary service with its own supplementary service code. The following logical states are applicable to each privacy class (refer to GSM 03.11 for an explanation of the notation):

Provisioning State	Registration State	Activation State	HLR Induction State
(Not Provisioned,	Not Applicable,	Not Active,	Not Induced)
(Provisioned,	Not Applicable,	Active and Operative,	Not Induced)

Table 2 Logical States for each LCS Privacy Class

For each LCS privacy class, the HLR shall store the logical state of the class on a per-subscriber (or per subscriber MSP) basis. In addition, the permanent data indicated below shall be stored on a per subscriber (or per subscriber MSP) basis when the logical provisioning state of the associated LCS privacy class is “provisioned”. For the meaning of each LCS privacy class, refer to section 7~~6.6~~ and to GSM 02.71.

LCS Privacy Class	Status	Additional HLR Data when Class is provisioned
Universal Class	-	No additional data
Call Related Class	-	No additional data

Call Unrelated Class	O
	
	O
	
	C
	
	O
	
	C
		Indication (Y/N) of whether notification to and privacy verification by the MS user is enabled for a restricted MT-LR from any value added LCS client
		
		External LCS client list: a list of zero~~one~~ or more LCS clients, with the following data stored for each LCS client in the list:
		- International E.164 address identifying a single LCS client or a single group of LCS clients that are permitted to locate this target MS
		- Indication (Y/N) of notification of a non-restricted MT-LR from this LCS client to the MS with one of the following:
		  - notification only
		  - notification with privacy verification
		- Restriction on the GMLC~~GPLMN (PLMN containing the GMLC)~~. Possible values are:
		  - ~~HPLMN~~identified GMLCs only
		  - Any GMLC~~PLMN~~ in the home country
		  - Any GMLC~~PLMN~~ (no restriction)

PLMN Operator Class	O	LCS client list: a list of one or more generic classes of LCS client that are allowed to locate the particular MS. The following classes are distinguished: - LCS client broadcasting location related information - O&M LCS client in the HPLMN - O&M LCS client in the VPLMN - LCS client recording anonymous location information - LCS Client supporting a bearer service, teleservice or supplementary service to the target MS
~~Self Location Class~~	-	~~No additional data~~

Table 3: LCS data stored in the HLR privacy exception list for an MS Subscriber (or MS Subscriber MSP)

LCS MS subscription data may include a mobile originating list containing the LCS mobile originating classes that an MS is permitted to request. Each LCS mobile originating class is treated as a distinct supplementary service with its own supplementary service code. The following logical states are applicable to each mobile originating class (refer to GSM 03.11 for an explanation of the notation):

Provisioning State	Registration State	Activation State	HLR Induction State
(Not Provisioned,	Not Applicable,	Not Active,	Not Induced)
(Provisioned,	Not Applicable,	Active and Operative,	Not Induced)

Table 4 Logical States for each Mobile Originating LCS Class

For each LCS Mobile Originating class, the HLR shall store the logical state of the class on a per-subscriber (or per subscriber MSP) basis. In this version of LCS, there is no additional permanent data in the HLR. The table below shows the defined mobile originating classes. For the meaning of each LCS mobile originating class, refer to section 7 and to GSM 02.71.

LCS Mobile Originating Class	Status	Additional HLR Data when Class is provisioned
Basic Self Location	-	No additional data
Autonomous Self Location	-	No additional data
Transfer to Third Party	-	No additional data

Table 5: Data stored in the HLR for the LCS Mobile Originating List for an MS (or MS Subscriber MSP)

In addition to the privacy exception list, the following other data items may be stored in the MS subscription profile in the HLR to support LCS:

Other Data in the HLR	Status	Description
Home GMLC List	O	List of one or more E.164 addresses of the GMLCs in the home PLMN from which a location request for an MT-LR is allowed, The addresses are only relevant to an LCS client that is restricted (in the MS privacy exception list) to making call unrelated location requests from the home PLMN.

Table 6: Temporary LCS data in the HLR

10.1.2.LCS data in the HLR for an Type A LMU with an NSS based SMLC

The IMSI is the primary key to LMU data for a Type A LMU stored in the HLR when the SMLC associated with the LMU is NSS based. Any subscription data that is applicable to an MS subscriber may be held by the HLR for an Type A LMU, since the LMU is treated by the HLR similarly to an MS subscriber. However, a HLR will normally restrict LMU subscription data to just the IMSI, MSISDN, SMS-PP MT (if assigned) and barring of all incoming and possibly outgoing calls. Use of MSPs is also unnecessary for an LMU. A Type A LMU has no HLR subscription when the SMLC associated with the LMU is BSS-based.

An HLR also needs to hold the following additional permanent data for an Type A LMU.

Additional LMU Data in HLR	Status	Description
LMU Indicator	M	Distinguishes an Type A LMU from a normal MS Subscriber

Table 7: Additional permanent data in the HLR for an Type A LMU

10.2.12.2 VLR

The VLR contains the same LCS permanent data for each registered MS subscriber and each Type A LMU when the SMLC associated with the LMU is NSS-based, as does the HLR. This data is downloaded to the VLR as part of the location update procedure between the VLR and HLR for either an MS subscriber or LMU. The VLR has no data for Type A LMUs when the SMLC associated with the LMU is BSS-based.

The VLR contains the following temporary data for any LMU

Temporary VLR Data Item	Status	Description
Location Information Confirmed in SMLC	M	Indication of whether the LMU was successfully registered in an associated SMLC with possible values -Confirmed (registered) -Not Confirmed (not registered)
SMLC address	C	Identity of the SMLC in which the LMU is registered -either international E.164 address -or SS7 signaling point code

12.3 Table 6: Temporary data in the VLR

10.3. GMLC

The GMLC holds data for a set of external LCS clients that may make call related or non-call related MT-LR requests to this GMLC. The permanent data administered for each LCS client is as follows.

LCS Client data in GMLC	Status	Description
LCS Client Type	M	Identifies the type LCS client from among the following: - Emergency Services - Value Added Services - PLMN Operator Services - Lawful Intercept Services
External identity	M	A list of one or more identifiers used to identify an external LCS client when making an MT-LR – the nature and content of the identifier(s) is outside the scope of this specification
Authentication data	M	Data employed to authenticate the identity of an LCS client – details are outside the scope of this specification
Call related identity	O	A list of one or more international E.164 addresses to identify the client for a call related MT-LR Each call related identity may be associated with a specific external identity
Non-call related identity	O	A list of one ore more international E.164 addresses to identify the client for a non-call related MT-LR. Each non-call related identity may be associated with a specific external identity
Override capability	O	Indication of whether the LCS client possesses the override capability (not applicable to a value added client)
Authorized MS List	O	A list of MSISDNs or groups of MSISDN for which the LCS client may issue a non-call related MT-LR. Separate lists of MSISDNs and groups of MSISDN may be associated with each distinct external or non-call related client identity.
Priority	M	The priority of the LCS client – to be treated as either the default priority when priority is not negotiated between the LCS server and client or the highest allowed priority when priority is negotiated
QoS parameters	M	The default QoS requirements for the LCS client, comprising: - Accuracy - Response time Separate default QoS parameters may be maintained for each distinct LCS client identity (external, non-call related, call related)
Allowed LCS Request Types	M	Indicates which ofif the following are allowed: - Non-call related MT-LR - Call related MT-LR - Specification or negotiation of priority

		- Specification or negotiation of QoS parameters - Request of current location - Request of initial location (for an emergency services call) - Request of current or last known location - Request of location and velocity
Local Coordinate System	O	Definition of the coordinate system(s) in which a location estimate shall be provided – details are outside the scope of this specification
Access Barring List(s)	O	List(s) of MSISDNs or groups of MSISDN for which a location request is barred

Table 9: GMLC Permanent Data for a LCS Client

~~10.4.~~12.4 SMLC

~~10.4.1.~~Common Data

The following table holds permanent BTS data:

Permanent BTS Data Item	**Status**	**Description**
BTS position	M	BTS position (latitude/longitude) of the Serving BTS
CGI	M	Cell global identity.
BSIC	M	Base station identity code.
BCCH	M	Frequency of the broadcast carrier.

Table 10: Permanent SMLC Data for a BTS

The SMLC holds data for its associated LMUs. The main key to LMU data in the SMLC is the IMSI ~~of the~~for a Type A LMU and a cell site identifier for a Type B LMU. LMU data provides the location capabilities of the LMU (e.g. which location and assistance measurements are supported). The following permanent data shall be administered for any LMU:

Permanent LMU Data Item	**Status**	**Description**
Type of LMU	M	Indicates if LMU is Type A or Type B
IMSI	C~~M~~	Main key to ~~LMU~~ data for a Type A LMU. Not applicable to a Type B LMU
LAC + CI	C	Cell site identifier to address a Type B LMU. Not applicable to a Type A LMU.
Signaling Access	M	Information regarding signaling access to the LMU including the following: - address of default serving BSC and/or serving MSC (a BSS based SMLC uses a serving BSC while an NSS based SMLC uses a serving MSC) - SS7 link set to serving BSC or serving MSC (or to an intermediate STP)
Serving Cell	M	Identity of the cell in which the LMU is physically located
Geographic location	C	Latitude/longitude coordinates Storage of coordinates is mandatory for TOA or E-OTD if an LMU is not co-located with a BTS
Position measurement functions	O	List of supported position measurements For each type of position measurement, a list of associated capabilities – details are outside the scope of this specification
Assistance measurement functions	O	List of supported assistance measurements For each type of assistance measurement, a list of associated capabilities – details are outside the scope of this specification
Diagnostic functions	O	List of supported diagnostic functions – details are outside the scope of this specification

Table 11: Permanent SMLC Data for an LMU

The SMLC also holds the following temporary data for each LMU flor which there has been any previous signaling interaction, where data items other than the registration state are only valid when the registration state is "registered".

Temporary LMU Data Item	Status	Description
Registration State	M	Indication of whether the LMU has successfully registered with possible values: -registered - not registered or de-registered
Serving MSC	CM	Identity of the current or most recent serving MSC (not applicable to a BSS based SMLC) - either international E.164 address - or SS7 signaling point code
LMSI	C	LMSI in serving VLR if provided during registration
Position Measurements	O	Ongoing and scheduled position measurements ordered in the LMU by the SMLC – details are outside the scope of this specification
Assistance Measurements	O	Ongoing and scheduled assistance measurements ordered by the SMLC – details are outside the scope of this specification
O&M Activities	O	Ongoing and scheduled O&M activities ordered in the LMU by the SMLC – details are outside the scope of this specification

Table 12: Temporary SMLC Data for an LMU

10.4.2.TOA Data

The following data are specific to TOA and shall be administered in the SMLC:

Permanent LMU Data Item	Status	Description
Number of Measurement Devices (Note 1)	M	Number of measurement devices contained in the LMU.
Number of Simultaneous Measurements (Note 2)	M	LMU total measurement capacity.
Data items for each measurement device:		
Beamwidth Orientation Gain Number of Simultaneous Measurements	M M O O	Azimuthal coverage in degrees for each LMU measurement device. Main beam pointing angle counter-clockwise looking down with respect to North in degrees for each LMU measurement device. LMU measurement device antenna gain at foresight in dB. Maximum measurement capacity in a single LMU measurement device. (Assume dedicated receivers if this field is not specified.)

Table 13: Permanent SMLC Data for an LMU

Note 1: The term "measurement device" is used both to indicate the LMU sector and to avoid confusion with the BTS sectors when LMU sectors are not coincident with BTS sectors.
Note 2: A "measurement" refers to the time interval required for an entire TOA measurement. If any portion of the interval overlaps, it is considered simultaneous.

An LMU contains no mandatory data regarding its associated SMLC. An LMU shall contain permanent data regarding its measurement and O&M capabilities and may contain pre-administered data regarding location assistance measurements and O&M activities that the LMU is to perform without the need for any command from the SMLC. The content of such location measurement and O&M related data is outside the scope of this specification.

~~10.5.~~12.5 Recovery and Restoration Procedures

The LCS recovery and restoration procedures allow temporary data to be recovered or reinitialized following loss or corruption of data, such that normal LCS service is rapidly restored and inconsistency between the data held by different LCS network elements is removed. For a full description, refer to GSM 03.07.

~~11.~~13. Operational Aspects

~~11.1.~~Charging

~~11.1.1.~~Charging Information collected by the PLMN serving the LCS Client

The following charging information shall be collected by the PLMN serving the LCS Client:

- Type and Identity of the LCS Client;
- Identity of the target MS;
- Results (e.g. success/failure, method used if known, response time, accuracy) - to be repeated for each instance of positioning for a deferred location request;
- Identity of the visited PLMN;
- LCS request type (i.e. LDR or LIR);
- State;
- Event (applicable to LDR requests only);
- Time Stamp;
- Type of coordinate system used.

~~11.1.2.~~Charging Information Collected by the Visited PLMN

The following charging information shall be collected by the visited PLMN:

- Date and time;
- Type and Identity of the LCS Client (if known)
- Identity of the target MS;
- Location of the target MS (e.g., MSC, location area ID, cell ID, location coordinates);
- Which location services were requested;
- Results (e.g. success/failure, positioning method used, response time, accuracy) - to be repeated for each instance of positioning for a batch location request;
- Identity of the GMLC or PLMN serving the LCS Client;
- State;
- Event (applicable to LDR requests only);

~~12.~~14. History

Version	Date	Issued by	Distributed to
V0.0.0	Nov. 1997	SIEMENS	T1P1.5
V0.0.1	Jan. 1998	SIEMENS	T1P1.5
V0.0.2	Feb. 1998	NOKIA	T1P1.5
V0.0.3	Mar. 1998	SIEMENS	T1P1.5
V0.0.4	April, 1998	Motorola	T1P1.5
V0.0.5	May, 1998	Motorola	T1P1.5
V0.0.6	June, 1998	Motorola	T1P1.5
V0.0.7	August, 1998	Motorola	T1P1.5
V0.0.8	September, 1998	Motorola	T1P1.5

V0.0.9	September, 1998	NORTEL	T1P1.5
V0.1.0	October, 1998	NORTEL	T1P1.5
V0.2.0	November, 1998	NORTEL Networks	T1P1.5
V0.3.0	December, 1998	NORTEL Networks	T1P1.5
V0.4.0	January, 1999	NORTEL Networks	T1P1.5
V0.5.0	January, 1999	NORTEL Networks	T1P1.5
V0.6.0	February, 1999	NORTEL Networks	T1P1.5
V1.0.0	February, 1999	NORTEL Networks	T1P1.5
V1.1.0	April, 1999	NORTEL Networks	T1P1.5
V1.1.1	April, 1999	NORTEL Networks	T1P1.5
V1.2.1	May, 1999	NORTEL Networks	T1P1.5
V2.0.0	June, 1999	NORTEL Networks	T1P1.5

Annex A (Informative) Examples of MT-LR

This Annex provides examples of both call related and non-call related mobile terminated location request from an external application, where multiple PLMNs are involved.

1. PLMN Roles

A PLMN can have one or more of the following roles in supporting the LCS service.

Gateway PLMN (GPLMN)	The PLMN in which a location request originates. For an MT-LR, the GPLMN contains the GMLC.
Home PLMN (HPLMN)	The home PLMN for the MS being located. The HPLMN contains the HLR for the located MS.
Visited PLMN (VPLMN)	The PLMN currently serving the MS being located. The VPLMN contains the MSC/VLR serving the located MS, the SMLC and any LMUs used to perform the location.

2. Non-Call Related MT-LR

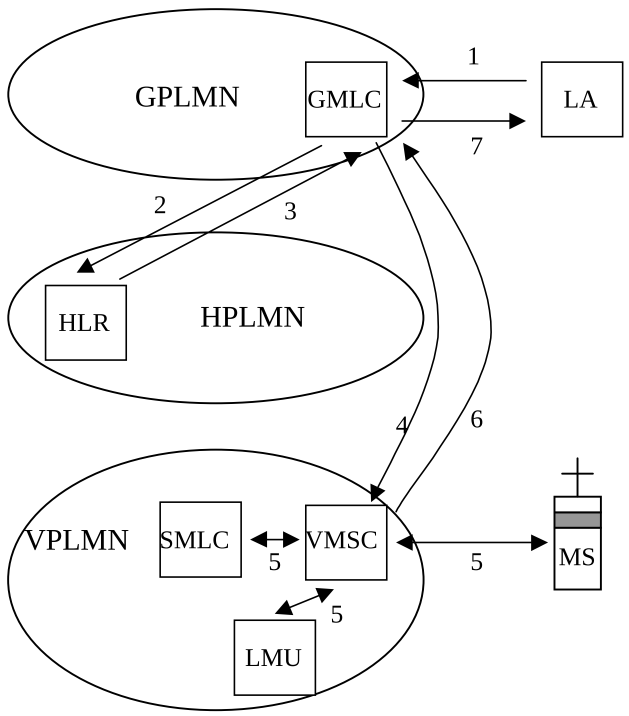


Figure 1 - Non-Call Related MT-LR

1. A external Location Application (LA) sends a Location Request to a GMLC in its serving GPLMN requesting the location of a particular MS.
2. The GMLC queries the HLR of the MS to be located by sending a MAP query to the HPLMN of this MS. In order to route the query to the HLR, translation of the MSISDN of the MS to be located will be required. This translation may be performed within the GMLC and/or may be performed by intermediate STPs.
3. The HLR returns the E.164 address of the VMSC currently serving the MS in the VPLMN.

4. The GMLC forwards the location request to the VMSC and includes within it the identity of the LA. In order to route the request to the VMSC, translation of the E.164 address of the VMSC will be required. This translation may be performed within the GMLC and/or may be performed by intermediate STPs.
5. The VMSC verifies that the MS allows a non-call relkated MT-LR in its privacy exception list and that the LA identity provided by the GMLC matches an LA identity in the MS privacy exception list. The VMSC then interacts with an SMLC and possibly one or more LMUs in the VPLMN to perform positioning of the MS.
6. The resulting location estimate is returned by the VMSC to the GMLC. The VMSC uses the E.164 address or SS7 signaling point code of the GMLC, provided in step 4, to correctly route the location estimate to the GMLC in the GPLMN.
7. The GMLC returns the location estimate to the requesting LA.

3. Call Related MT-LR

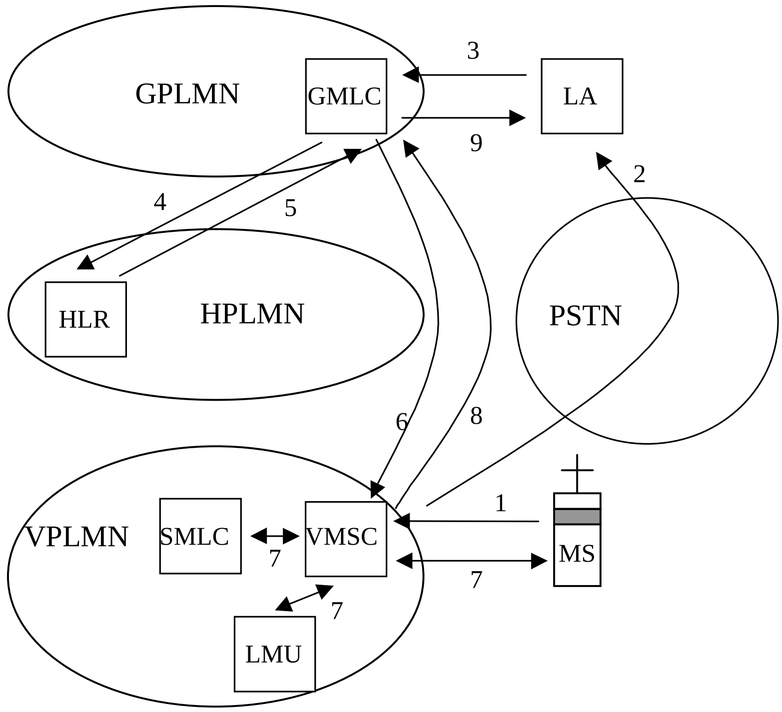


Figure 2 - Call Related MT-LR

1. An MS requests a voice or data call to some external Location Application (LA).
2. The call is routed from the VMSC through the PSTN to the LA. The MSC stores the original dialed number and the PSTN or PSPDN number that was used to route the call if different.
3. The external LA obtains the MSISDN of the calling MS – either verbally or using calling line ID presentation. The LA may also need to verify the number dialed by the MS – e.g. if the LA can be reached by any of several dialed numbers. The external LA sends a Location Request to a GMLC in its serving GPLMN requesting the location of the MS and providing both the MSISDN and its own PSTN PSPDN number as used by the MS.
4. The GMLC queries the HLR of the MS to be located by sending a MAP query to the HPLMN of this MS. In order to route the query to the HLR, translation of the MSISDN of the MS to be located will be required. This translation may be performed within the GMLC and/or may be performed by intermediate STPs.
5. The HLR returns the E.164 address of the VMSC currently serving the MS in the VPLMN.
6. The GMLC forwards the location request to the VMSC and includes within it the PSTN or PSPDN number of the LA. In order to route the request to the VMSC, translation of the E.164 address of the VMSC will be required. This translation may be performed within the GMLC and/or may be performed by intermediate STPs.

7. The VMSC verifies that the MS allows a call related MT-LR in its privacy exception list, that it currently has an originated call established and that the PSTN or PSPDN number supplied by the GMLC matches the number either dialed by the MS or used to route the call. The VMSC then interacts with an SMLC and possibly one or more LMUs in the VPLMN to perform positioning of the MS.
8. The resulting location estimate is returned by the VMSC to the GMLC. The VMSC uses the E.164 address or SS7 signaling point code of the GMLC, provided in step 4, to correctly route the location estimate to the GMLC in the GPLMN.
9. The GMLC returns the location estimate to the requesting LA.

Annex B (Informative) Description of TOA

The uplink TOA positioning method is based on measuring the Time of Arival (TOA) of a known signal sent from the mobile and received at three or more measurement units. The known signal is the access bursts generated by having the mobile perform an asynchronous handover. This method will work with existing mobiles; i.e. there is no modification to the handset required.

The Serving Mobile Location Center (SMLC) calculates Time Difference of Arrival (TDOA) values by pair-wise subtracting the TOA values. The mobile position is then calculated via hyperbolic trilateration assuming that:

a) the geographical coordinates of the measurement units are known, and
b) the timing offset between the measurement units involved in the measurement are known, *e.g.* by the use of absolute GPS time at the measurement units, or by using reference measurement units (sometimes referred to as "reference mobiles") situated at known locations to determine RTD (Real Time Difference) values.

Access bursts are used for detecting the TOA at the listening measurement units. At a positioning request, the units which should measure the TOA of the MS signal are selected and configured to listen at the correct frequency. The MS is then forced to perform an asynchronous handover.. Under such circumstances, the MS is transmitting up to 70 access bursts (320 ms) with specified power on a traffic channel (which may be frequency hopping).

The TOA measurements are performed at each measurement unit by integrating the received bursts to enhance the sensitivity, and therefore increasing the detection probability and measurement accuracy, and by applying a multipath rejection technique to accurately measure the arrival time of the Line of Sight component of the signal. The presence of diversity, e.g. antenna diversity and frequency hopping will improve the multipath rejection capability and therefore the measurement accuracy.

When an application requires the position of a mobile, it has to send a request to SMLC the identifacation of the mobile and the accuracy level parameter. Depending on this accuracy level, SMLC decides how many measurement units to be included in the positioning request. The measured TOA values together with the accuracy parameter of the TOA value are collected and transmitted to the SMLC. The SMLC utilizes the TOA measurements in combination with information about the coordinates of the measurement units and the RTD values (a and b above) to produce a position estimate. The SMLC delivers the position estimate together with an uncertainty estimate to the application.

The uplink TOA method requires additional hardware (LMUs) to accurately measure the arrival time of the bursts. Different implementation options exist for this positioning method. For instance, it is possible to either integrate the measuring units in the BTSs or implement them as stand-alone units. In case the measurement units are implemented as stand alone units, the communication between the measurement units and the network is preferably carried out over the air interface. The stand-alone units may have separate antennas or share antennas with an existing BTS.

Annex ~~B~~C (Informative) Description of E-OTD

1. Basic Concepts

The Enhanced Observed Time Difference (E-OTD) positioning method is developed from the Observed Time Difference (OTD) feature. For synchronised networks, the MS measures relative time of arrival of the signals from several BTSs. For unsynchronised networks, the signals are also received by a fixed measuring point known as the Location Measurement Unit (LMU) whose location is known. The position of the MS is determined by deducing the geometrical components of the time delays to an MS from the BTSs.

Measurements are performed by the MS without any additional hardware. For OTD measurements synchronization, normal and dummy bursts can be used. When the transmission frames of BTSs are not synchronized, the network needs to measure the Real Time Differences between them. To obtain accurate triangulation, OTD measurements and, for non-synchronized BTSs, RTD measurements are needed for at least three geographically distinct BTSs. Based on the measured OTD values, the location of the MS can be calculated either in the network or, if all the needed information is available in MS, in the MS itself. The terms 'MS-assisted' applies to the former method and 'MS-based' to the latter.

Note that in this document, the term OTD is used to refer to a quantity of time, whereas the E-OTD is used to refer to a positioning method.

2. Position Calculation Types

The location estimate is performed by a Position Calculation Function (PCF) located in the MS or in the network. With the same network architecture, MS functions, LMU functions and measurement inputs the PCF can be based on one of two possible types of E-OTD location calculation; known as ‘hyperbolic’ and ‘circular’.

The hyperbolic type is introduced in section (a) below followed by a brief description of the circular type in section (b).

(a) Hyperbolic Type

There are three basic timing quantities associated with this type of E-OTD location calculation:

- Observed Time Difference (OTD). This means the time interval that is observed by a mobile station (MS) between the reception of signals (bursts) from two different Base Transceiver Stations (BTS) in the cellular network. A burst from the BTS 1 is received at the moment t1, and a burst from the BTS 2 is received at the moment t2. Thus the OTD value in this case is: OTD = t2 - t1. If the two bursts arrive exactly at the same moment, then OTD = 0.
- Real Time Difference (RTD). This means the relative synchronization difference in the network between two BTSs. If the BTS 1 sends a burst at the moment t3, and the BTS 2 at the moment t4, the RTD between them is: RTD = t4 - t3. If the BTSs transmit exactly at the same time that means that the network is synchronized and there is no need to calculate RTDs, hence RTDs = 0.
- Geometric Time Difference (GTD). This is the time difference between the reception (by an MS) of bursts from two different base stations due to geometry. If the length of the propagation path between the BTS 1 and the mobile station is d1, and the length of the path between the BTS 2 and the MS is d2, then GTD = (d2 - d1) / υ, where υ is the speed of radio waves. If both BTSs are exactly as far from the MS, GTD = 0.

The relationship between these three quantities is:
OTD = RTD + GTD.

OTD is the quantity measured by the mobile station to be located. RTD is a quantity related to the network (BTSs). GTD is a quantity related to the geometry of the situation (positions of the mobile and BTSs). GTD is the actual quantity that is useful for location purposes, since it contains information about the position of the MS. If only OTD values are known, no location can be calculated, thus also RTD values must be known.

The MS location estimate can be computed in the MS or by the network depending on implementation. Whichever method is used the MS location estimate is calculated from the GTD (as calculated from the measured OTD and known or measured RTD) based on the fact that the possible location for the MS observing a constant GTD value (d2 - d1 = constant) between two BTSs is a hyperbola. The MS can be located in the intersection of two hyperbolas obtained with three base stations and two GTDs. If more GTDs are available the possible location area can be reduced.

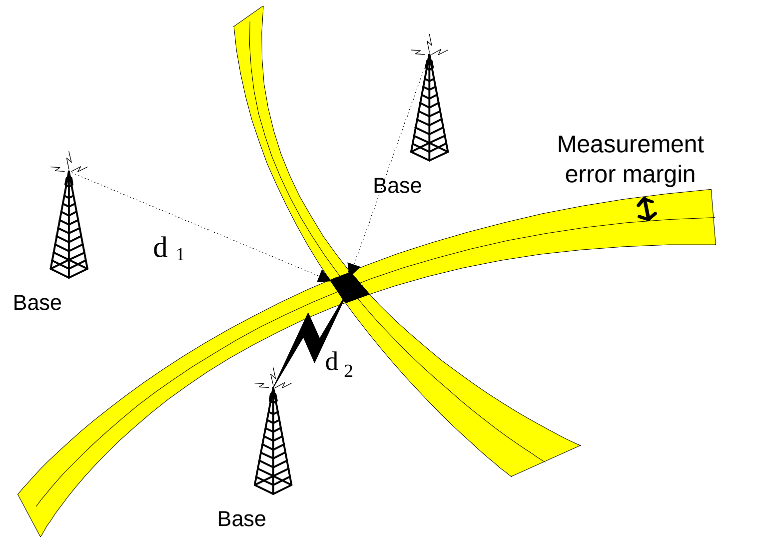


Figure 6~~13~~~~126~~. E-OTD location (hyperbolic).

The dashed line represents the determined GTD, i.e., represents a constant difference in distance to two BTSs. The measurement result is not exact, thus the gray area represents the area of uncertainty for the MS based on that OTD measurement. The black area at the intersection of the hyperbolas is the calculated most likely location for the MS.

(b) Circular Type

The E-OTD Circular location calculation type does not measure time differences at the MS and LMU between the receipt of signals from pairs of BTSs. Rather, it measures the arrival time of those signals individually.
There are five quantities associated with the circular type of E-OTD:

- The Observed Time at the MS (MOT) at which a signal arrives from a BTS. This is a time measured against the MS's internal clock.
- The Observed Time at the LMU (LOT) at which a signal arrives from a BTS. This is a time measured against the LMU's internal clock. In general there will be a time offset ε between the MS's internal clock and the LMU's internal clock.
- The geometrical Distance from MS to BTS (DMB).
- The geometrical Distance from LMU to BTS (DLB).

These quantities are related by:
DMB - DLB = υ (MOT - LOT + ε)
in which υ is the speed of the signals (speed of radio waves) and there will be one such equation for each BTS. Since there are three unknown quantities (MS position x, y and clock offset ε) at least three BTSs are required to solve for the MS location and the unknown clock offset ε. This is the same total number of BTSs as is required for the hyperbolic type of E-OTD. The position of the MS is defined by the intersection of circles centred on the BTSs common to observations made by the MS and LMUs, hence the notation 'circular' as the E-OTD type as shown in Figure 2 below.

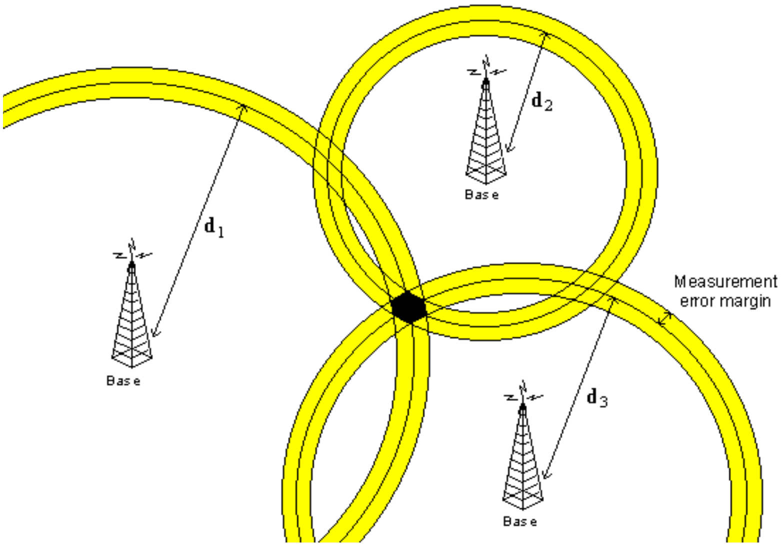


Figure 2. E-OTD location (circular).

The hyperbolic and circular types differ in the relationship between the MS measurement error margin and the geographic location of the MS relative to BTSs. In all other respects the implementation is identical.

3. Implementation Issues

If the Timing Advance (TA) to the serving BTS is known, i.e. the mobile station is in active mode, the ring represented by the TA can also be included in location determination. For a sectored serving cell the TA ring will be reduced to a segment of a ring thus improving the location estimate.
The E-OTD calculation process depends on the MS being able to 'hear' a sufficient number of BTSs whose timing is known. The 'hearability' of the E-OTD location method depends on many factors but in general good hearability results in a system with improved coverage and location determination accuracy.
Both hyperbolic and circular types require a minimum of three spatially distinct BTSs. However use of more measurements brings improved accuracy.

Location is possible when the MS is idle or dedicated (in-call) modes. Continuous location (tracking) or single location can be requested. Continuous location is more feasible in the mobile based architecture, because uplink signaling is not needed at all. If BTSs transmit their coordinates and RTD values by using a method such as Cell Broadcast (SMS-CB), the MS has sufficient information to calculate its own position when in idle mode. This idle mode location makes possible a very high frequency of measurements, thus allowing use of advanced filtering both in OTD measurements and location estimates.
An implementation of the E-OTD location method is expected to require an LMU to BTS ratio between 1:3 and 1:5.

Annex D (Informative) Description Of Assisted GPS

The Global Positioning System (GPS) provides a means to determine position, velocity, and time around the globe. GPS uses satellites emitting radio signals to the receiver to determine the position of the receiver, often on the surface of the Earth. A satellite system generally consists of satellites, receivers, and monitor and control stations as shown in Figure 1.

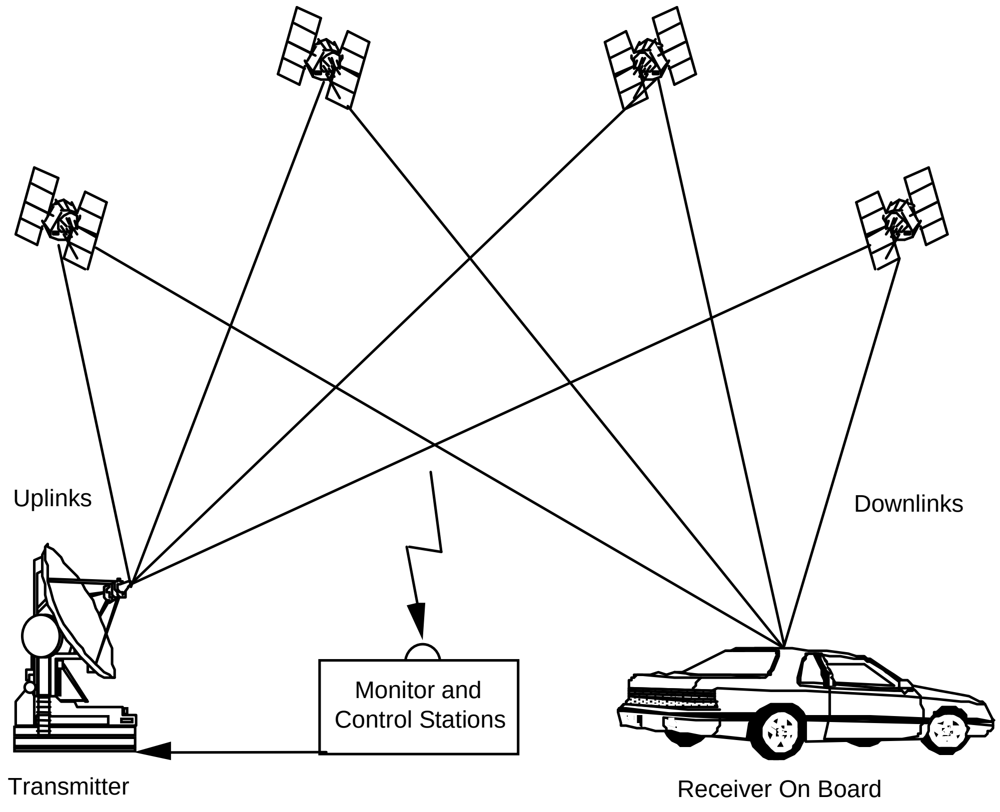


Figure 1. A typical GPS positioning system.

The four satellites shown in Figure 1 emit radio signals from space. GPS satellites transmit a direct-sequence spread-spectrum (DS-SS) signal at 1.023 Mchip/sec with a code period of one millisecond. All satellites transmit at 1575.42 MHz using code-division multiple-access (CDMA) techniques. Each satellite's DS-SS signal is modulated by a navigation message that includes accurate time and a description of the satellite's position. A GPS receiver in the vehicle, connected with an antenna which receives the radio signals to calculate its position. The ground network includes several monitor stations that observe the satellite signals and a master control station that uploads the data to the satellites. The GPS constellation consists of 24 satellites orbiting at an altitude of 20,183.61 kilometers above the Earth's surface.

Positioning measurement of the GPS receiver is based on the time of arrival (TOA) principle. When 4 or more satellites are in line of sight from the receiver (or receiving antenna), the latitude, longitude, and altitude of the receiver are determined. Standard positioning service (SPS), a grade of GPS service, is available for commercial applications, including the mobile phone location determination. The SPS is deliberately degraded by selective availability (SA) and provides horizontal position accuracy within a circle of 100-meter radius 95% of the time. Much better accuracy can be obtained by utilizing differential correction techniques. Differential GPS (DGPS) can reduce the position error to under 5 meters, while SA and other error factors are in effect. It uses a reference receiver at a surveyed position to send correcting information to a mobile receiver over a communications link.

As mentioned above, GPS is based on the TOA principle. Figure 2 is used to depict a simplified two-dimensional view of this principle. A TOA system determines the position based on the intersection of the distance (or range) circles. The range is calculated from the signal transmission time, which is derived by multiplying the time by the speed of the signal. Three range measurements determine a unique position. Geometric accuracy is the highest within the triangle formed by the centers of the three circles. The accuracy gradually decreases as one moves away from the triangle. GPS uses the same principle, where the circle becomes the sphere in space and a fourth measurement is required to solve the receiver-clock offset. Because the receiver and satellite clocks are unsynchronized prior to the measurement, the signal transmission time determined by the GPS receiver is not the true transmission time. As a result, the corresponding range measurement becomes a pseudorange measurement.

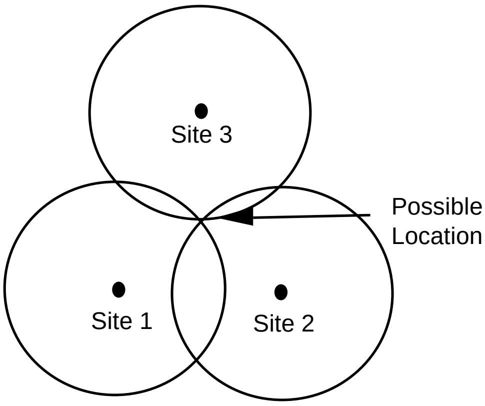


Figure 2. Time of Arrival (TOA) positioning system.

To solve the clock offset between the receiver clock and satellite clock, a fourth satellite is used. Although the satellite clocks are unsynchronized, the individual clocks are modeled to meter-level accuracy by the GPS ground network. As a result, both the receiver position and clock offset can be derived from the equations below.

$$p_1 = \sqrt{(x-x_1)^2 + (y-y_1)^2 + (z-z_1)^2} + c(dT_1 - dt)$$
$$p_2 = \sqrt{(x-x_2)^2 + (y-y_2)^2 + (z-z_2)^2} + c(dT_2 - dt)$$
$$p_3 = \sqrt{(x-x_3)^2 + (y-y_3)^2 + (z-z_3)^2} + c(dT_3 - dt)$$
$$p_4 = \sqrt{(x-x_4)^2 + (y-y_4)^2 + (z-z_4)^2} + c(dT_4 - dt)$$

where (x_1 , y_1 , z_1), (x_2 , y_2 , z_2), (x_3 , y_3 , z_3), and (x_4 , y_4 , z_4) are the known satellite positions, p_1, p_2, p_3, and p_4 are measured pseudoranges, c is the speed of light, dT_1, dT_2, dT_3, dT_4 are the known satellite clock bias terms from GPS time, and dt is the unknown receiver clock offset from GPS time. The satellite clock bias terms are derived by the receiver from the satellite navigation message. For simplicity, several error terms have been left out in the above equations. The square-root term represents the geometric range between the satellite and receiver, and all the other terms contribute to the measurement being a pseudorange.

There are four main functions for a conventional GPS receiver:

1. Measuring distance from the satellites to the receiver by determining the pseudoranges (code phases);

2. Extracting the time of arrival of the signal from the contents of the satellite transmitted message;
3. Computing the position of the satellites by evaluating the ephemeris data at the indicated time of arrival.;
4. Determining the position of the receiving antenna and the clock bias of the receiver by using the above data items using an iterative solution.

To reduce the errors contributed from satellite clock and position modeling, ionospheric delay, tropospheric delay, and selective availability (SA), corrections can be done before the Function 4 above. The most important technique for error correction is DGPS.

D.1 Assisted-GPS

The basic idea is to establish a GPS reference network (or a wide-area differential GPS network) whose receivers have clear views of the sky and can operate continuously. This reference network is also connected with the GSM network. At the request of an MS- or network-based application, the assistance data from the reference network is transmitted to the MS to increase performance of the GPS sensor. For classification, when the position is calculated at the network, we call it mobile-assisted solution. When the position is calculated at the handset, we call it mobile-based solution. If implemented properly, the assisted-GPS method should be able to

1. Reduce the sensor start-up time;
2. Increase the sensor sensitivity; and
3. Consume less handset power than conventional GPS does.

Additional assisted data, such as differential GPS corrections, approximate handset location or cell base station location, and others can be transmitted to improve the location accuracy and decrease acquisition time.

If the GPS receiver does not know its approximate location, it will not be able to determine the visible satellites or estimate the range and Doppler frequency of these satellites. It has to search the entire code phase and frequency spaces to locate the visible satellites. For the code phase space, it spans from 0 to 1023 chips. For the frequency space, it spans from –4kHz to +4kHz. The relative movements between the satellites and receiver make the search even more time-consuming. Therefore, the time-to-first-fix (TTFF) is one important parameter to evaluate the quality of a receiver. For standalone GPS, this time could be more than 10 minutes. Clearly, this is unacceptable for certain applications such as E911. By transmitting assistance data over the GSM network, we can reduce the TTFF of a receiver to a few seconds. It significantly reduces the search window of the code phase and frequency spaces, hence, the start-up time. Furthermore, because of the availability of the satellite navigation message transmitted via the cellular network, it can also assist the receiver when the satellite signals are too weak to demodulate useful information. It reduces the handset power dissipation by going to the idle mode whenever there is no need for location services.

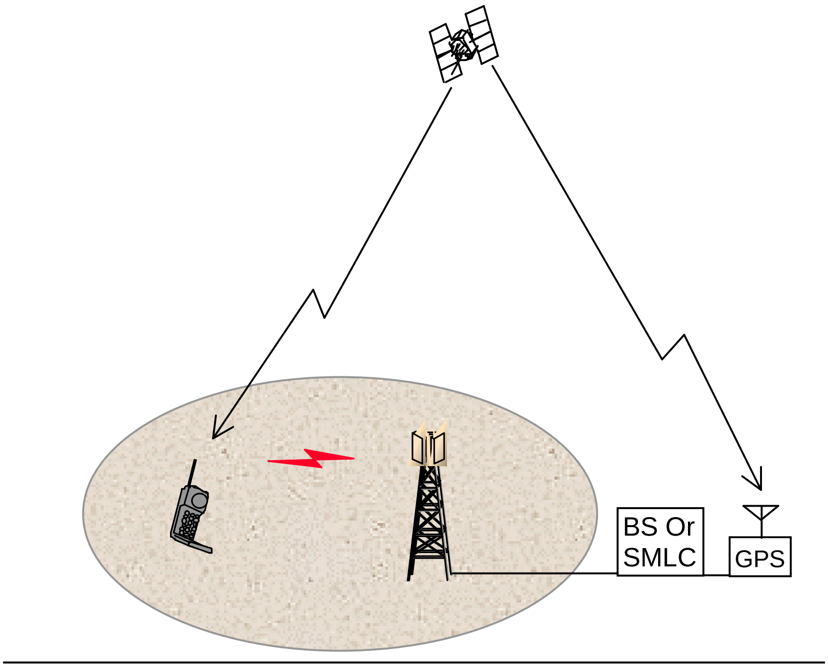


Figure 3. Assisted-GPS positioning system.
(BS stands for Base Station and SMLC stands for Serving Mobile Location Center)

D.2 MS-Assisted GPS

The mobile-assisted solution shifts the majority of the traditional GPS receiver functions to the network processor. This method requires an antenna, RF section, and digital processor for making measurments by generating replica codes and correlating them with the received GPS signals. The network transmits a very short assistance message to the mobile station (MS), consisting of time, visible satellite list, satellite signal Doppler, and code phase search window. These parameters help the embedded GPS sensor reduce the GPS acquisition time considerably. These assistance data are valid for a few minutes. It returns from the MS the pseudorange data processed by the GPS sensor. After receiving the pseduorange data, the corresponding network processor or location server estimates the position of the MS. The differential correction can be applied to the final result at the network side to improve the position accuracy.

D.3 MS-Based GPS

The MS-based solution maintains a fully-functional GPS receiver in the MS. This requires the same functionality as described in clause B.2, plus additional means for computing the positions of the satelites and ultimately the MS's position. In the initial start-up scenario, significantly more data must be provided to the MS than for the MS-assisted case. However, this data is valid for four hours or more and can be updated as necessary over time. Typical transmissions include time, reference location, satellite ephemeris and clock corrections. If better position accuracy is required for certain applications, DGPS data must be transmitted to the MS frequently (approximately every 30 seconds). Since the DGPS data is valid for a large geographical area, one centrally located reference receiver can be used to service this large region. The final position of the MS is generated at the MS itself. The calculated MS location can then be sent to an application outside of the MS if required.

Annex ~~DEC~~ New LCS Messages and Parameters

1. BSSAP-LE Messages

BSSAP-LE messages provide an extension to BSSAP (both to DTAP and BSSMAP) and may be transferred on the Ls, Lb, Lp and A interfaces. The new messages are assumed to be defined in a new GSM 09.xx.

(a) Perform Location Request (BSSMAP)

Purpose: instigate positioning attempt for a target MS
Initiator: MSC or BSC
Recipient: SMLC
Interfaces: Ls, Lb, A
SCCP usage: connection oriented
Parameters: similar to phase 1 MAP Perform Location invoke
BSSLAP message – optional (allows a BSC to add measurement data for a BSS based SMLC)

(b) Perform Location Response (BSSMAP)

Purpose: return positioning result for a target MS
Initiator: SMLC
Recipient: MSC or BSC
Interfaces: Ls, Lb, A
SCCP usage: connection oriented
Parameters: similar to phase 1 MAP Perform Location return result
use Cause parameter for equivalent of MAP Perform Location return error

(c) Open LMU Connection (BSSMAP)

Purpose: setup an SDCCH to a type A LMU
Initiator: SMLC or MSC
Recipient: MSC, BSC or SMLC
Interfaces: Ls, Lb, A
SCCP usage: connection oriented
Parameters: IMSI of LMU
address of initiator (SMLC or MSC)
request or confirm authentication flag
request or confirm ciphering flag

(d) Open LMU Connection Ack. (BSSMAP)

Purpose: confirm setup or failure of an SDCCH to a type A LMU
Initiator: SMLC or MSC

Recipient: MSC, BSC or SMLC
Interfaces: Ls, Lb, A
SCCP usage: connection oriented
Parameters: cause if SDCCH setup failed

request or confirm authentication flag
request or confirm ciphering flag

(e) Close LMU Connection (BSSMAP)

Purpose: release an SDCCH to a type A LMU
Initiator: SMLC or MSC
Recipient: MSC, BSC or SMLC
Interfaces: Ls, Lb, A
SCCP usage: connection oriented
Parameters: cause value

(f) Connection Oriented Information (BSSMAP)

Purpose: convey an embedded message between an SMLC and another entity associated with the SMLC through an existing signaling connection or chain of signaling connections (e.g. SCCP connection, SDCCH). Allow extension later for other applications.
Other Entity: target MS, serving BSC
Interfaces: Lb, Ls, A, Um
SCCP usage: connection oriented
BSSAP: BSSMAP-LE mode
Parameters: RRLP (04.xx) message (valid for transfer to/from a target MS)
BSSLAP (08.71) message (valid for transfer to/from a serving BSC)
RRLP end flag - indicate end of a segmented RRLP message
RRLP command flag - indicate an RRLP positioning command (valid in the first BSSMAP-LE message for any SMLC to MS RRLP message transfer)

(g) Connectionless Information (BSSMAP)

Purpose: convey an embedded LCS message between an SMLC and another entity for which there is no (e.g. SCCP) connection association
Other Entity: type B LMU or SMLC
Interfaces: Lb, Ls, Lp, A
SCCP usage: connectionless
BSSAP: BSSMAP-LE mode
Parameters: LLP (04.71) message or SMLCPP (08.yy) message
LAC (+ CI) – identifies the LMU or SMLC
return error flag – used to request an error response in case of non-delivery
cause value – used to indicate the presence of an error response

(h) REGISTER (DTAP)

Purpose: open a signaling transaction between an SMLC and type A LMU and enable transfer of an embedded LLP message.
Other Entity: Type A LMU
Interfaces: Lb, Ls, A, Um
SCCP usage: connection oriented
BSSAP: DTAP mode
Parameters: Transaction ID
LCS protocol discriminator
LLP (04.71) message
Release Forbidden

(i) FACILITY (DTAP)

Purpose: continue a signaling transaction between an SMLC and type A LMU and enable transfer of an embedded LLP message.
Other Entity: Type A LMU
Interfaces: Lb, Ls, A, Um
SCCP usage: connection oriented
BSSAP: DTAP mode
Parameters: Transaction ID
LCS protocol discriminator
LLP (04.71) message
Release Forbidden

(j) RELEASE COMPLETE (DTAP)

Purpose: close a signaling transaction between an SMLC and type A LMU and enable transfer of an embedded LLP message.
Other Entity: Type A LMU
Interfaces: Lb, Ls, A, Um
SCCP usage: connection oriented
BSSAP: DTAP mode
Parameters: Transaction ID
LCS protocol discriminator
LLP (04.71) message

2. New RR Messages – for GSM 04.08

(a) Location Information

Purpose: convey an embedded LCS RRLP message to or from a Target MS
Other Entity: target MS
Interfaces: Um
Parameters: RRLP (04.xx) message
RRLP end flag - indicate end of a segmented RRLP message

3. New Abis messages for 08.58

Generic LCS information messages are needed in GSM 08.58 to support signaling to a type B LMU. Either a single bidirectional or two unidirectional messages could be defined.

4. Possible new messages and parameters for LLP in GSM 04.71

(a) Status Update (LMU to SMLC)

Purpose: message sent by an LMU to an SMLC both periodically and when some significant event occurs (e.g. power on, recovery from failure) conveying status information.
Content: status of LMU (e.g. power up, recovery, normal operation)
status of activities in LMU – for TOA, RTD, GPS, O&M
detailed HW status

Note: this message may not be so necessary for a BSS based SMLC if the Location Update and IMSI Detach procedures are supported by the LMU and SMLC (see section 7).

Annex EF D Open Issues List

Number	Description	Status	Resolution
001	Use of DTAP versus RR signaling to a target MS and Type A or B LMU	Open 6/7/99 Closed 7/9/99	Agree RR signaling to a target MS Agree DTAP signaling to an LMU
002	Should the SMLC to SMLC peer protocol (SMLCPP) be defined in GSM 04.71 or in a separate TS	Open 6/7/99 Closed 7/9/99 Reopen 8/10/99 Closed 8/13/99	Agree a new 08.yy Define new messages but also allow transfer of (e.g. embedded) LLP messages (from 04.71) For 3G, a new 08.yy is preferable (for the Iur interface)
003	Need names and abbreviations for the new LCS protocols	Open 6/7/99 Closed 7/9/99	Defined in section 2
004	Should the SMLC use a single generic LCS information message to exchange LCS information for all other types of entity or should several more specialized messages be defined.	Open 6/7/99 Closed 7/9/99	Agree 1 connectionless BSSMAP message and 1 connection oriented BSSMAP/DTAP message.
005	Is an LMU registration procedure and/or LMU service request procedure needed – e.g. in GSM 04.71 or 09.02.	Open 6/7/99 Closed 8/13/99	Registration is not needed for a BSSAP based interface to an SMLC.
006	Should an SMLC be allowed to return a location estimate (e.g. derived from CI + TA) in an SCCP Connection Refused message.	Open 6/7/99 Closed 7/9/99	Yes
007	Is it legitimate for an LMU to send a DTAP CM Service Request in order to establish an LCS signaling link to the SMLC. Since a CM Service Request contains an MM protocol discriminator, routing to a BSS based SMLC by a BSC may not be possible.	Open 6/7/99 Closed 7/20/99	It is proposed to assign a new establishment cause value in an RR Channel Request to identify a request for an SDCCH from an LMU. This impacts 04.08. The LMU indication should then be transferred to the MSC in a Complete Layer 3 Information (impact to 08.08) to enable MSC verification of LMU status. These changes will allow correct routing by the BSC, distinct treatment of LMUs when assigning an SDCCH and distinct early processing in the MSC.
008	When a BSS based SMLC attempts to	Open	It is expected that the BSC will always

	open a signaling link to a type A LMU where signaling is NSS assisted, can the BSC determine whether an SDCCH already exists to the LMU based on the IMSI provided by the SMLC.	6/7/99 Closed 8/13/99	know the IMSI of an LMU where a signaling channel has been assigned – this should also apply to GPRS and 3G.
009	Should the RRLP protocol to a target MS be the same as the LLP protocol to an LMU defined in GSM 04.71.	Open 7/6/99 Closed 7/9/99 Reopen 8/10/99 Closed 8/13/99	RRLP is different and will be defined in a new GSM 04.xx. BSC support of LCS interaction with RR management procedures (e.g. handover) can be supported using generic LCS information messages in the BSSAP-LE and RR protocol layers. This allows RRLP to be transparent to a BSC.
010	Need to define specific LCS BSSMAP subsets for the A interface.	Open 7/6/99	
011	Definition of BSSMAP-LE messages in a new 09.xx versus new 08.xx	Open 7/6/99 Closed 7/9/99	Agree a new 09.xx. Applicability to the BSC, SMLC and MSC should be made clear in the scope of this TS.
012	Should a single DTAP-LE LCS Information message be supported for a type A LMU rather than separate REGISTER, FACILITY, and RELEASE COMPLETE messages as in phase 1.	Open 7/6/99 Closed 7/20/99	REGISTER, FACILITY and RELEASE COMPLETE messages will be used as in phase 1. These allow multiple transactions (e.g. separate transactions for TOA, RTD, O&M messages), more explicit opening and closing of signaling connections and better error handling. Changes to 04.71 are also avoided.
013	Should distinct RR LCS Information messages be defined for uplink versus downlink transfer.	Open 7/6/99 Closed 7/9/99 Reopen 8/10/99 Closed 8/13/99	A single RR LCS Information message will be used for both uplink and downlink. SMG12 suggested that RRLP messages could be part of 04.08: an RR LCS Information message in 04.08 is then not needed. On examination of this issue together with issue 9, it was found that BSC suppport of RR interaction with positioning remains feasible with RRLP not in 04.08.
014	Should O&M for type A or B LMUs be allowed using circuit or GPRS calls.	Open 7/6/99 Closed 7/20/99	O&M to an LMU using a circuit data connection.will be supported as an option.
015	Should the stage 2 message flows include details of SCCP usage or should these be in a separate GSM TS.	Open 7/6/99 Closed 7/9/99	SCCP details will be defined in a separate section in the LCS stage 2. Message flows will not contain SCCP details except for a few key steps – e.g. setup and release of an SCCP

			connection. SCCP details will not be included in stage 3 (e.g. as suggested by SMG12) – at least for LCS phase 2.
016	Should a BSC be enabled to request the location of a target MS when in idle mode.	Open 7/6/99 Closed 7/9/99	No usage for a BSC positioning request in idle mode has been found. Possible usage could exist later for GPRS.
017	Should an NI-LR from a BSC be supported with an NSS based SMLC. If so, should the location request from the BSC to MSC be different to the BSSMAP-LE Perform Location Request	Open 7/8/99 Closed 8/13/99	Agree that a BSC NI-LR must be supported by an NSS based SMLC – e.g. to avoid inconsistent service in a network with both NSS and BSS based SMLCs. Use the same BSSMAP-LE Position Request and Response – with an indication of the type of LCS client.
018	Should MSC/VLR signaling procedures always be supported in the SMLC to enable information transfer between a BSS based SMLC and type B LMU without NSS assistance.	Open 7/6/99 Closed 7/9/99	Agree MSC/VLR signaling shall be supported by the SMLC.
019	Should an MO-LR be supported using existing call independent supplementary service procedures	Open 7/6/99 Closed 7/9/99	Yes
020	Are both type A and type B LMUs needed? For a type B LMU, should authentication and ciphering be mandatory, optional or not supported?	Open 7/9/99 Closed 8/13/99	Only a Type A LMU (supporting normal GSM RR and MM air interface signaling including normal GSM authentication and ciphering) will be defined for LCS. A Type B LMU supporting a subset of MM signaling (e.g. without authentication and ciphering) will not be defined. This is in agreement with comments from SMG10 and SMG12.
021	Should X.25 be allowed as an alternative to MTP/SCCP signaling on the Ls, Lb and Lp interfaces?	Open 7/9/99 Closed 7/20/99	Only SS7 (MTP/SCCP) signaling will be defined for signaling to an SMLC. Other signaling transport mechanisms will be allowed by the basic architecture for GPRS and 3G.
022	Should connectionless SCCP signaling, possibly using TCAP/MAP, be allowed on the Ls (and maybe Lb) interface? If so, can this be accommodated by including a phase 1 SMLC?	Open 7/9/99 Closed 8/13/99	Signaling between an SMLC and MSC/VLR will be based on BSSAP and (for 2nd generation circuit oriented LCS systems) SCCP and MTP. There will be no support of MAP signaling, as in LCS phase 1.
023	To authenticate a type A LMU, an SMLC needs either administration data	Open 7/9/99	This issue now applies to a type A LMU only.

	~~or a MAP link to an HLR/AC. With the former, an SMLC needs to possess AC authentication and ciphering algorithms.~~		
~~024~~	~~Routing on LAC + CI is assumed in the MSC and BSC to transfer LCS data to a type B LMU. Routing on LAC (+CI) is assumed in the MSC to transfer SMLCPP messages to an SMLC.~~	~~Open 7/9/99 Closed 8/13/99~~	~~SMG12 comment is that in 3G, the LAC but not CI may be used to address an SMLC or type B LMU in an MSC. The CI could still be transferred to the BSS.~~
~~025~~	~~Should signaling to an LMU using a TCH be supported? If so, should the lower signaling layers be defined – e.g. L1 – transparent synchronous data at rates up to 64 Kbps, L2 – RLP (supports multislot HSCSD operation), L3 – DTAP-LE, L4 – LLP.~~	~~Open 7/19/99 Closed 7/20/99~~	~~Signaling using a TCH will be allowed (see item 14). The lower signaling layers will be defined.~~
~~026~~	~~For an MO-LR, should there be a separate message flow using different DTAP and BSSMAP-LE messages to request LCS assistance data versus a location estimate?~~	~~Open 7/19/99 Closed 7/20/99~~	~~One message flow will be defined to support requests for both LCS assistance data and a location estimate.~~
~~027~~	~~Assuming LMU signaling on a TCH is supported, assignment of a TCH for a BSS based SMLC can be simplified if the DTAP call control messages between the SMLC and LMU are omitted. However, this would lead to different LMU signaling than for TCH assignment to an NSS based SMLC.~~	~~Open 7/19/99 Closed 8/13/99~~	~~Agree to retain DTAP call control messages to avoid different variants of an LMU.~~
~~028~~	~~Investigate the use of WAP and MExE to support O&M to a type A LMU. This could be alternative to use of a TCH.~~	~~Open 8/10/99~~	~~One advantage of WAP is that it should provide end-to-end authentication.~~

3GPP TSG-CN-WG1, Meeting #8
25-29 October 1999
Kobe, Japan

Tdoc N1-99C14

CHANGE REQUEST

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

04.71 CR A001 Current Version: 7.0.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑ *↑ CR number as allocated by MCC support team*

For submission to: TSGN1
list expected approval meeting # here ↑

for approval	X	strategic		(for SMG use only)
for information		non-strategic		

Form: CR cover sheet, version 2 for 3GPP and SMG *The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc*

Proposed change affects: (U)SIM [ ] ME [ ] UTRAN / Radio [ ] Core Network [X]
(at least one should be marked with an X)

Source: T1P1.5 **Date:** 25.10.99

Subject: Addition of further LCS functionality in GSM Release 98

Work item: Location Services (LCS)

Category: *(only one category Shall be marked With an X)*

F	Correction		**Release:**	Phase 2	
A	Corresponds to a correction in an earlier release			Release 96	
B	Addition of feature			Release 97	
C	Functional modification of feature	X		Release 98	X
D	Editorial modification			Release 99	
				Release 00	

Reason for change: Replace Location Service protocol with LLP. Add Status Query and Status Update message.

Clauses affected:

Other specs affected:

Other releases of same spec		→ List of CRs:
Other core specifications	X	→ List of CRs:
MS test specifications / TBRs		→ List of CRs:
BSS test specifications		→ List of CRs:
O&M specifications		→ List of CRs:

Other comments:

TS 04.71 V7.0.0 (1999-08)

Technical Specification

Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 Location Services (LCS) specification;

(GSM 04.71 version 7.0.0 Release 1998)

GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

ETSI

Reference

DTS/SMG030471Q7 (00003i03.PDF)

Keywords

DIGITAL CELLULAR TELECOMMUNICATIONS SYSTEM, GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS (GSM)

ETSI

Postal address

F-06921 Sophia Antipolis Cedex - FRANCE

Office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Internet

secretariat@etsi.fr
Individual copies of this ETSI deliverable
can be downloaded from
http://www.etsi.org
If you find errors in the present document, send your
comment to: editor@etsi.fr

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available **free of charge** from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://www.etsi.org/ipr).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Specification (TS) has been produced by the Special Mobile Group (SMG).

The present document defines the coding of information necessary for support of location service operation on the mobile radio interface layer 3 within the digital cellular telecommunications system.

The contents of this specification are subject to continuing work within SMG and T1P1 and may change following formal SMG and T1P1 approval. Should SMG or T1P1 modify the contents of this specification it will then be re-issued with an identifying change of release date and an increase in version number as follows:

Version 7.x.y

where:

7 GSM Phase 2+ Release 1998;

x the second digit is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.;

y the third digit is incremented when editorial only changes have been incorporated in the specification.

1 Scope

The present document contains the coding of information necessary for support of location service operation on the mobile radio interface layer 3.

Clause 4 defines generic procedures for the control of location services. In clause 5 location service support procedures are defined. Clause 6 gives the functional definitions and contents of messages for location service operations. Clause 7 gives the general format and coding for messages used for location service and the format and coding of information elements used for location service operations between the LMU and MSC. Clause 6 gives the general message format and information elements coding between the LMU and SMLC.

Clause 8 gives the specification of the LMU LCS Protocol (LLP) ~~location service~~ operations. In clause 9 LMU – SMLC messages, data types and identifiers are given.

This version does not support segmentation of messages.

2 Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.
- For this Release 1998 document, references to GSM documents are for Release 1998 versions (version 7.x.y).

[1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 04.06: "Digital cellular telecommunications system (Phase 2+); Mobile Station - Base Station System (MS - BSS) interface Data Link (DL) layer specification".

[3] GSM 04.07: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface signalling layer 3; General aspects".

[4] GSM 04.08: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification".

[5] GSM 03.71: " Digital cellular telecommunications system (Phase 2+); Location Services (LCS); (Functional description) - Stage 2"

[6] GSM 09.02: "Digital cellular telecommunications system (Phase 2+); Mobile Application Part (MAP) specification".

[7] ITU-T Recommendation X.691: "Specification of packet encoding rules for Abstract Syntax Notation One (ASN.1)".

[8] ITU-T Recommendation X.690: "Specification of basic encoding rules for Abstract Syntax Notation One (ASN.1)".

[9] ITU-T Recommendation X.680: "Specification of Abstract Syntax Notation One (ASN.1)" 1994.

[10] ITU-T Recommendation Q.773: "Transaction capabilities formats and encoding".

[11] CCITT Recommendation X.208: ""Specification of Abstract Syntax Notation One (ASN.1) 1988".

3 Abbreviations

Abbreviations used in this specification are listed in GSM 01.04 and GSM 03.71.

4 Generic procedures for the control of location services

4.1 Overview of the generic protocol and its scope

One generic protocol is defined for the control of location services at the radio interface. This protocol operates at layer 3 of the radio interface and assumes the use of layers 1 and 2 conform to GSM 05-series and GSM 04.04, GSM 04.05 and GSM 04.06. The generic protocol uses the acknowledged information transfer service available at the layer 2 - layer 3 interface.

The Functional protocol is based on the use of the Facility information element and the FACILITY message as well as other specific functional messages specified in this specification.

4.2 Functional procedures for the control of location services

4.2.1 General

This clause specifies the functional signalling procedures for the control of location services at the radio interface.

The functional protocol utilizes functions and services defined in GSM 04.08 and the functions of the data link layer as defined in GSM 04.06. This protocol utilizes also definitions in GSM 04.07.

The Common Information Element Category utilizes the Facility information element to transport the protocol defined in this specification. The use of the Facility information element is common to many services, and its contents indicates what type of procedure is being requested. This category can be signalled both in the LMU to network and the network to LMU directions.

The correlation of location service operations and their responses, is provided by the combination of the transaction identifier of the messages containing the Facility information element and the Invoke identifier present within the Facility information element itself.

4.2.2 Common Information Element Category

The Common Information Element Category uses operations defined in this specification for location services signalling. Procedures are initiated by sending an operation including an invoke component. The invoke component may yield a Return Error, Return Result or Reject component (also included in an operation) depending on the outcome of the procedure.

The operation state machines, and procedures for management of Invoke IDs specified in CCITT Recommendation Q.774 White Book are used.

A REGISTER message, a FACILITY message or RELEASE COMPLETE message is used to carry the Facility information element which includes these operations. These operations request, acknowledge or reject the desired location service procedure.

4.2.3 Location service procedures

4.2.3.1 Introduction

For location service procedures independent of any call, the initiating side must establish a MM-connection between the network and the LMU according to the rules given in GSM 04.07 and 04.08. The LMU or the network starts the transaction by transferring a REGISTER message across the radio interface. This transaction is identified by the transaction identifier associated with the REGISTER message present in the component part of the Facility information element. Following the REGISTER message one or more FACILITY messages may be transmitted, all of them related by the use of the same transaction identifier. If the transaction is no longer used, it shall be released by sending a RELEASE COMPLETE message. This procedure is specified in detail in clause 5, and the text in clause5 takes precedence over this introduction.

To convey the location service invocation, the Facility information element is used. The Facility information element present either in the REGISTER message or a subsequent message identifies the location service involved and the type of component (i.e. Invoke, Return result, Return error or Reject component).

When the REGISTER or FACILITY message contains a Facility information element and the requested service is available, a FACILITY message containing a Facility information element may be returned. One or more exchanges of FACILITY messages may subsequently occur. To terminate the service interaction and release the transaction identifier value, a RELEASE COMPLETE message is sent as specified for the specific location service procedure. The RELEASE COMPLETE message may also contain the Facility information element.

4.2.3.2 Handling of protocol errors in LCS procedures

Messages containing a Facility information element shall be checked for protocol errors before the contents of the Facility IE is acted on. The checks shall be performed in the following order:

1) The message carrying the Facility IE shall be checked for protocol errors as specified in subclause 3.7. If a protocol error is found then the procedures in subclause 5.7 apply.

2) The contents of the Facility IE shall be checked for protocol errors as specified in subclause 4.2.6. If a protocol error is found then the procedures in subclause 4.2.6 apply.

4.2.3.3 Handling of other errors in LCS procedures

If the tests specified in subclause 4.2.3.2 have been passed without the detection of a protocol error, the receiver will attempt to process the contents of the Facility Information Element. If errors occur during this processing (e.g. system failure, or information in the Facility IE is incompatible with the requested operation) then the procedures specified in the individual service specifications apply.

An example of the behaviour that could occur in this case is:

- the LMU or network sends a Facility information element containing a return error component in a FACILITY or RELEASE COMPLETE message. If the FACILITY message is used then the MM Connection may continue to be used for further signalling.

4.2.4 Multiple location service invocations

It is possible for several LCS transactions to be used simultaneously. LCS transactions can also exist in parallel with other CM-Layer and MM transactions. The handling of multiple MM connections is defined in GSM 04.07 and 04.08.

A single Facility Information Element shall not contain more than one component.

4.2.5 Recovery procedures

In case a transaction is not terminated according to the normal procedure as described in this specification the network side has to ensure that the transaction is terminated e.g. by a supervision timer.

4.2.6 Generic protocol error handling for the component part of location services operations

If a location service operation is to be rejected the operation will be denied, and provided the transaction is still in progress, an appropriate reject component will be returned in a Facility Information Element.

4.2.6.1 Single component errors

The reject component shall be sent in a RELEASE COMPLETE message.

If the component containing the error was itself sent in a RELEASE COMPLETE message then the contents of the component shall be ignored, and no reject component is sent.

4.2.6.2 Multiple component errors

If a single Facility IE contains more than one component then a RELEASE COMPLETE message with the cause "Facility rejected" and without any component shall be sent.

5 Location service support procedures

5.1 General

This clause describes the location service support procedures at the radio interface. These procedures are provided by the location service support entity defined in GSM 04.07. The location service support procedures provide the means to transfer messages for the location service procedures. These procedures are regarded as the user of the location service support.

5.2 Location service support establishment

At the beginning of each location service procedure a location service support must be established.

5.2.1 Location service support establishment at the originating side

If the entity that uses the location support procedures needs to send a REGISTER message, the location service support entity shall first request the establishment of an MM-connection. This MM-connection is established according to GSM 04.08 and 04.07. If the network is the initiating side then MM-connection establishment may involve paging the LMU.

The location service support entity shall send the REGISTER message as the first CM-message on the MM-connection. The REGISTER message is sent to the corresponding peer entity on the MM-connection and the location service support shall be regarded as being established.

5.2.2 Location service support establishment at the terminating side

At the terminating side a location service support is regarded as being established when an MM-connection is established. According GSM 04.08 this can be ascertained by the receipt of the first message, with a new transaction identifier. For successful establishment of location service support this message shall be a REGISTER message.

If the terminating side needs to reject the establishment of location services support then it may be immediately initiate location services support release (see subclause 5.4).

5.3 Location service support information transfer phase

After the establishment of the location service support both users may exchange FACILITY messages by use of the location service support.

5.4 Location service support release

At the end of each location service procedure the established location service support is released, if a permanent connection is not used.

The side closing the transaction shall release the transaction by sending the RELEASE COMPLETE message to its corresponding peer entity.

Both location service support entities release the MM-connection locally.

5.5 Recovery procedures

The location service support does not provide recovery procedures, i.e. the operations are transparent to the location service support.

5.6 Message flow (single operation example)

This subclause contains examples of message flows for a single transaction consisting of a single operation. These examples may not show all possibilities.

5.6.1 LMU initiated location service transaction

```
LMU                                                                    Network

                                  REGISTER
------------------------------------------------------------------------------>
          Facility (Invoke = Operation (Location service code, Parameter(s)))

                        RELEASE COMPLETE or FACILITY
<------------------------------------------------------------------------------
                Facility (Return result = Operation (Parameter(s)))

                        RELEASE COMPLETE or FACILITY
<- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
                          Facility (Return error (Error))

                              RELEASE COMPLETE
<- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
                      Facility (Reject (Invoke_problem))

                          RELEASE COMPLETE (note)
<- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                          RELEASE COMPLETE (note)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - ->
```

NOTE: To prevent transactions being kept open following exceptional cases, either side of the transaction may release it by sending a RELEASE COMPETE message without a Facility IE.

Figure 3.1: LMU initiated location service transaction

5.6.2 Network initiated location service transaction

```
LMU                                                                    Network

                                  REGISTER
<------------------------------------------------------------------------------
          Facility (Invoke = Operation (Location service code, Parameter(s)))
```

RELEASE COMPLETE or FACILITY (note 1)
--->
Facility (Return result = Operation (Parameter(s))

RELEASE COMPLETE or FACILITY (note 1)
- ->
Facility (Return error (Error))

RELEASE COMPLETE (note 1)
- ->
Facility (Reject (Invoke_problem))

RELEASE COMPLETE (note 1, note 2)
- - - - -- ->

RELEASE COMPLETE (note 2)
<- -

NOTE 1: If the network initiated operation does not require a result, reject or error to be returned then the LMU may release the transaction by sending a RELEASE COMPLETE message without a Facility Information Element and release of transaction by LMU is allowed (i.e. Release Forbidden has not been present in Register message). If release is not allowed by LMU, the LMU sends the result using Facility message.

NOTE 2: To prevent transactions being kept open following exceptional cases, either side of the transaction may release it by sending a RELEASE COMPETE message without a Facility IE.

Figure 3.2: Network initiated location service transaction

5.7 Handling of unknown, unforeseen, and erroneous protocol data

5.7.1 General

These procedures only apply to messages where the protocol discriminator is set to indicate LCS operations according to the rules in GSM 04.07 and this specification. Messages that do not meet this criteria are treated according to other GSM technical specifications.

This subclause specifies procedures for handling of unknown, unforeseen and erroneous protocol data by the receiving entity. The procedures are called "error handling procedures", but they also define a compatibility mechanism for future extension of the protocol.

Most error handling procedures are mandatory in the LMU, but optional in the network. Detailed error handling procedures may vary from PLMN to PLMN.

In this subclause, the following terminology is used:

- An IE is defined to be syntactically incorrect in a message if it contains at least one value defined as "reserved" in this specification or GSM 04.08. However, it is not a syntactical error if a type 4 IE specifies a length indicator greater than that defined. The component part of the Facility information element is handled by a separate mechanism, and errors in the component part are not covered by this subclause.

The following procedures are listed in order of precedence.

Handling of errors in the contents of the Facility IE is described in subclause 4.2.6, and is outside the scope of this subclause.

5.7.2 Message too short

When a message is received that is too short to contain a complete message type information element, that message shall be ignored.

5.7.3 Unknown or unforeseen transaction identifier

The LMU shall ignore messages with the transaction identifier value set to "111".

If the transaction identifier value is not "111" the following procedures shall apply to the LMU:

a) If a RELEASE COMPLETE message is received specifying a transaction identifier that is not recognized as relating to a LCS transaction that is in progress then the message shall be ignored.

b) If a FACILITY message is received specifying a transaction identifier that is not recognized as relating to a LCS transaction that is in progress then a RELEASE COMPLETE message shall be sent.

c) If a REGISTER message is received specifying a transaction identifier that is not recognized as relating to a LCS transaction that is in progress and with a transaction identifier flag incorrectly set to "1", this message shall be ignored.

The network may follow the same procedures.

5.7.4 Unknown or unforeseen message type

If the LMU receives a message type not defined for the protocol discriminator or not implemented by the receiver, then a RELEASE COMPLETE message shall be sent with cause value #97 "message type non-existent or not implemented".

If the LMU receives a message type not consistent with the transaction state then a RELEASE COMPLETE message shall be sent with cause value #98 "message not compatible with control state".

The network may follow the same procedures.

5.7.5 Non-semantical mandatory Information Element Error

When on receipt of a message:

- an "imperative message part" error; or
- a "missing mandatory IE" error;

is diagnosed, or when a message containing:

- a syntactically incorrect mandatory IE; or
- an IE unknown in the message, but encoded as "comprehension required" (see GSM 04.08); or
- an out of sequence IE encoded as "comprehension required";

is received, the LMU shall proceed as follows:

a) If the message is not RELEASE COMPLETE it shall send a RELEASE COMPLETE message with cause "#96 - Invalid mandatory information".

b) If the message is RELEASE COMPLETE, it shall be treated as a normal RELEASE COMPLETE message.

The network may follow the same procedures.

5.7.6 Unknown and Unforeseen IEs in the non-imperative part

5.7.6.1 IEIs unknown in the message

The LMU shall ignore all IEs unknown in the message which are not encoded as "comprehension required". The network shall take the same approach.

5.7.6.2 Out of sequence IEs

The LMU shall ignore all out of sequence IEs in a message which are not encoded as "comprehension required".

The network may take the same approach.

5.7.6.3 Repeated IEs

If an information element with format T, TV or TLV (see GSM 04.07) is repeated in a message in which repetition of the information element is not specified, only the contents of the information element appearing first shall be handled and all subsequent repetitions of the information element shall be ignored. When repetition of information elements is specified, only the contents of specified repeated information elements shall be handled. If the limit on repetition of information elements is exceeded, the contents of information elements appearing first up to the limit of repetitions shall be handled and all subsequent repetitions of the information element shall be ignored.

The network may follow the same procedures.

5.7.7 Non-imperative message part errors

This category includes:

- syntactically incorrect optional IEs;
- conditional IE errors.

Errors in the content of the Facility IE are handled according to subclause 4.2.6.

5.7.7.1 Syntactically incorrect optional IEs (other than Facility)

The LMU shall treat all optional IEs that are syntactically incorrect in a message as not present in the message

The network shall take the same approach.

5.7.7.2 Conditional IE errors

When the LMU upon receipt of a message diagnoses a "missing conditional IE" error, or an "unexpected conditional IE error", or when it receives a message containing at least one syntactically incorrect conditional IE (other than Facility), it shall send a RELEASE COMPLETE message with cause #100 "conditional IE error".

The network may follow the same procedure.

6 Message functional definitions and contents

6.1 General

This clause defines the structure of the messages of the layer 3 protocol defined in GSM 03.71. These messages are standard L3 messages as defined in GSM 04.07.

Each definition includes:

a) a brief description of the message;

b) a table listing the information elements in the order of their appearance in the message. In a sequence of consecutive IEs with half octet length, the first IE occupies bits 1 to 4 of octet N, the second bits 5 to 8 of octet N, the third bits 1 to 4 of octet N+1 etc.;

For each IE the table indicates:

1) the information element identifier, in hexadecimal notation, if the IE has format T, TV or TLV. If the IEI has half octet length, it is specified by a notation representing the IEI as a hexadecimal digit followed by a "-" (example: B-);

2) the name of the IE (which gives an idea of the semantics of the element), which is used in this and other specifications as a reference to the IE within the message;

3) the name of the type of the IE (which indicates the coding of the value part of the IE), and a reference to a description of the value part of the IE;

4) the presence requirement indication (M, C or O) for the IE, as defined in GSM 04.07;

5) the format of the IE (T, V, TV, LV, TLV) as defined in GSM 04.07;

6) the length of the IE (or permissible range of lengths), in octets, in the message, where "?" means that the maximum length of the IE is only constrained by the link layer protocol, and in the case of the facility IE by possible further considerations specified in GSM 03.71. This indication is non-normative.

c) subclauses specifying conditions for IEs with presence requirement C or O in the relevant message. Together with other conditions specified in this specification and GSM 03.71 defines when the IE shall be included or not, what non-presence of such IEs means, and (for IEs with presence requirement C) the static conditions for presence and/or non-presence of the IEs (see GSM 04.07).

6.2 Messages for location services control

Table 4.1 summarises the messages for location services control.

The logical DTAP LCS Information Request and DTAP LCS Information Report messages, that are used in LCS Stage 2 (GSM 03.71), are transported using REGISTER, FACILITY and RELEASE COMPLETE messages.

If there exists no LCS transaction between LMU and MSC, REGISTER message is used to deliver the logical message. If LCS transaction between LMU and MSC exists, FACILITY message is used to deliver the logical message. RELEASE COMPLETE message is used to indicate that LCS transaction is not any more needed, LMU can also use this message to transport logical LCS Information Response message.

Table 4.1: Messages for location service control

Messages for location service control	Reference
FACILITY	46.3
REGISTER	46.4
RELEASE COMPLETE	46.5

6.3 Facility

This message is sent by the Location Measurement Unit (LMU) or the network to request or acknowledge a location service. It is used when information is to be conveyed and the transaction already exists, but is not to be released. The location service to be invoked, and its associated parameters, are specified in the Facility information element (see table 4.2). This message contains information transparent to MSC.

Table 4.2: FACILITY message content

IEI	Information element	Type / Reference	Presence	Format	Length
	Location service Protocol discriminator	Protocol discriminator ~~5~~7.2	M	V	1/2
	Transaction identifier	Transaction identifier ~~5~~7.3	M	V	1/2
	Facility Message type	Message type ~~5~~7.4	M	V	1
	Facility	Facility ~~5~~7.5	M	LV	2-?
90	Release forbidden	Release forbidden ~~5~~7.6	O	T	1

6.4 Register

6.4.1 Register (network to LMU direction)

This message is sent by the network to the location measurement unit to assign a new transaction identifier for location service control and to request or acknowledge a location service (see table 4.3). This message contains information transparent to MSC.

Table 4.3: REGISTER message content (network to LMU direction)

IEI	Information element	Type / Reference	Presence	Format	Length
	Location service Protocol discriminator	Protocol discriminator ~~5~~7.2	M	V	1/2
	Transaction identifier	Transaction identifier ~~5~~7.3	M	V	1/2
	Register Message type	Message type ~~5~~7.4	M	V	1
	Facility	Facility ~~5~~7.5	M	LV	2-?
90	Release forbidden	Release forbidden ~~5~~7.6	O	T	1

6.4.2 Register (LMU to network direction)

This message is sent by the location measurement unit to the network to assign a new transaction identifier for location service control and to request or acknowledge a location service (see table 4.4). This message contains information transparent to MSC.

Table 4.4: REGISTER message content (LMU to network direction)

IEI	Information element	Type / Reference	Presence	Format	Length
	Location service protocol discriminator	Protocol discriminator ~~5~~7.2	M	V	1/2
	Transaction identifier	Transaction identifier ~~5~~7.3	M	V	1/2
	Register Message type	Message type ~~5~~7.4	M	V	1
	Facility	Facility ~~5~~7.5	M	LV	2-?

6.5 Release complete

This message is sent by the location measurement unit or the network to release a transaction used for location service control. It may also request or acknowledge a location service (see table 4.5). This message contains information transparent to MSC.

Table 4.5: RELEASE COMPLETE message content

IEI	Information element	Type / Reference	Presence	Format	Length
	Location service protocol discriminator	Protocol discriminator ~~5~~7.2	M	V	1/2
	Transaction identifier	Transaction identifier ~~5~~7.3	M	V	1/2
	Release Complete message type	Message type ~~5~~7.4	M	V	1
10	Cause	Cause GSM 04.08	O	TLV	4-32
11	Facility	Facility ~~5~~7.5	O	TLV	2-?

6.5.1 Cause

This information element shall be included when the functional handling of the Cause IE is specified in the service description. If the functional handling of the Cause IE is not specified, the receiving entity may ignore the IE. The Cause IE used in location services is defined in GSM 04.08 in Clause 10.5.4.11 (only applicable Cause values are used).

6.5.2 Facility

This information element shall be included as required by the service description and the procedures defined in this specification and in GSM 03.71.

7 General message format and information elements coding between LMU and MSC

The figures and text in this clause describe message contents. Within each octet, the bit designated "bit 1" is transmitted first, followed by bits 2, 3, 4, etc. Similarly, the octet shown at the top of each figure is sent first.

7.1 Overview

Within the layer 3 protocol defined in this specification, every message is a standard L3 message as defined in GSM 04.07. This means that the message consists of the following parts:

a) protocol discriminator;

b) transaction identifier;

c) message type;

d) other information elements, as required.

Unless specified otherwise, a particular information element may be present only once in a given message.

When a field extends over more than one octet, the order of bit values progressively decreases as the octet number increases. The least significant bit of the field is represented by the lowest numbered bit of the highest numbered octet of the field.

7.2 Protocol discriminator

The Protocol Discriminator (PD) and its use are defined in GSM 04.07. This specification defines the protocols relating to the PD values:

1 1 0 0 location services

7.3 Transaction identifier

For general rules, format and coding of transaction identifier values, see GSM 04.08.

7.4 Message type

The message type IE and its use are defined in GSM 04.07. Table 5.1 defines the value part of the message type IE used in the location service protocol.

Table 5.1: Message types

8	7	6	5	4	3	2	1	Message types
0	X	1	0	.	.	.	.	Clearing messages:
				0	0	0	1	- RELEASE COMPLETE
0	X	1	1	.	.	.	.	Miscellaneous message group:
				0	0	0	1	- FACILITY
				0	0	1	0	- REGISTER
NOTE 1: Bit 8 is reserved for possible future use as an extension bit, see GSM 04.07. NOTE 2: Bit 7 is reserved for the send sequence number in messages sent from the mobile station. In messages sent from the network, bit 7 is coded with a "0", see GSM 04.07.								

7.5 Facility information element

The purpose of the Facility information element is to indicate the invocation and operation of location services, identified by the corresponding operation code within the Facility information element.

The Facility information element is coded as shown in figure 5.1 and clause 8.

The Facility is a type 4 information element with no upper length limit except that given by the maximum number of octets in a L3 message, see GSM 04.06.

8	7	6	5	4	3	2	1	
Facility IEI								octet 1
Length of Facility contents								octet 2
Component(s) (note)								octet 3 etc.
NOTE: This component contains Transparent LCS Information. Encoding of this component is according to clause 8.								

Figure 5.1: Facility information element

7.6 Release forbidden

This information element is used only in MSC to LMU messages. The presence of IE indicates that the release of LCS transaction is not allowed by LMU.

8 General message format and information elements coding between LMU and SMLC

8.1 Transparent LCS Information

This clause provides the formats and encoding of Transparent LCS Information component in the Facility information element. The contents of this component is copied directly from Signal Info from MAP message (see the clause 6.1.4). Formats and encoding methods make use of and is a subset of ITU-T Recommendation Q.773 (Transaction Capabilities formats and Encoding) and T/S 43/BB. The used part of ITU-T Recommendation Q.773 respectively T/S 43/BB is almost the same as the Component Portion of TC messages.

This subclause is further based on:

- ~~ITU-T~~ CCITTRecommendation X.208~~680~~ (Specification of Abstract Syntax Notation One (ASN.1)), 1988;
- ITU-T Recommendation X.691 (Specification of packet encoding rules for Abstract Syntax Notation One);

and is consistent with these ITU-Trecommendations. BASIC-PER, unaligned variant is used.

NOTE: Concerning the general rules for encoding (structure of encoding, identifier octets, length octets, etc.) see CCITT~~ITU-T~~ Recommendations X.208~~680~~ and ITU-T Recommendation X.691. For these general rules the same exceptions apply as stated in GSM 09.02. Following ASN.1 definitions are exactly same than in ITU-T Recommendation Q.773.

```
Component ::=  CHOICE {
   invoke                [1] IMPLICIT Invoke,
   returnResultLast         [2] IMPLICIT ReturnResult,
   returnError           [3] IMPLICIT ReturnError,
   reject                [4] IMPLICIT Reject,
   returnResultNotLast      [7] IMPLICIT ReturnResult }

-- The Components are sequences of data elements.

Invoke ::=     SEQUENCE {
   invokeID          InvokeIdType,
   linkedID          [0] IMPLICIT InvokeIdType OPTIONAL,
   operationCode        OPERATION,
   parameter            ANY DEFINED BY operationCode OPTIONAL }

-- ANY is filled by the single ASN.1 data type following the keyword PARAMETER or the keyword
ARGUMENT
-- in the type definition of a particular operation.

ReturnResult ::=  SEQUENCE {
   invokeID          InvokeIdType,
   result            SEQUENCE {
   operationCode        OPERATION,
   parameter            ANY DEFINED BY operationCode
   } OPTIONAL
   }

-- ANY is filled by the single ASN.1 data type following the keyword RESULT in the type definition
-- of a particular operation.

ReturnError ::=   SEQUENCE {
   invokeID          InvokeIdType,
   errorCode            ERROR,
   parameter            ANY DEFINED BY errorCode OPTIONAL }

-- ANY is filled by the single ASN.1 data type following the keyword PARAMETER in the type
definition
-- of a particular error.

Reject ::=     SEQUENCE {
   invokeID CHOICE {
      derivable         InvokeIdType,
      not-derivable        NULL },
   problem CHOICE {
      generalProblem    [0] IMPLICIT GeneralProblem,
      invokeProblem     [1] IMPLICIT InvokeProblem,
```

```
      returnResultProblem     [2] IMPLICIT ReturnResultProblem,
      returnErrorProblem      [3] IMPLICIT ReturnErrorProblem } }

InvokeIdType ::=  INTEGER (–128..127)
```

8.1.1 Operation Code

Each Operation is assigned an Operation Code to identify it. The Operation Codes for the different Operations are defined in subclause 9.2.

8.1.2 Error Code

Each Error is assigned a value (Error Code) to identify it. The Error Codes for the different Errors are defined in subclause 7.3.

8.1.3 Problem Code

The Problem Code consists of one of the four elements: General Problem, Invoke Problem, Return Result Problem or Return Error Problem. ASN.1 definitions are presented below.

```
-- PROBLEMS

GeneralProblem    ::=   INTEGER {      unrecognizedComponent (0),
                        mistypedComponent (1),
                        badlyStructuredComponent (2) }

InvokeProblem     ::=   INTEGER {      duplicateInvokeID (0),
                        unrecognizedOperation (1),
                        mistypedParameter (2),
                        resourceLimitation (3),
                        initiatingRelease (4),
                        unrecognizedLinkedID (5),
                        linkedResponseUnexpected (6),
                        unexpectedLinkedOperation (7) }

ReturnResultProblem  ::=   INTEGER {      unrecognizedInvokeID (0),
                        returnResultUnexpected (1),
                        mistypedParameter (2) }

ReturnErrorProblem   ::=   INTEGER {      unrecognizedInvokeID (0),
                        returnErrorUnexpected (1),
                        unrecognizedError (2),
                        unexpectedError (3),
                        mistypedParameter (4) }
```

9 LMU LCS Protocol ~~Location services~~ operation specifications

9.1 General

This clause specifies the abstract syntax for the LMU LCS Protocol ~~Location Service protocol~~ using the Abstract Syntax Notation One (ASN.1), defined in ~~ITU~~ CCITT Recommendation X.208~~680~~ (198~~9~~8).

The encoding rules which are applicable to the defined abstract syntax are the Packet Encoding Rules for Abstract Syntax Notation One, defined in ITU-T Recommendation X.691. For each Location Service parameter which has to be transferred by a Location Service message, there is a PDU field (an ASN.1 NamedType) whose ASN.1 identifier has the same name as the corresponding parameter, except for the differences required by the ASN.1 notation (blanks between words are removed, the first letter of the first word is lower-case and the first letter of the following words are capitalized (e.g. "bearer service" is mapped to "bearerService"). In addition some words may be abbreviated as follows:

- lmu location measurement unit;
- lcs location services;

The ASN.1 data type which follows the keywords ARGUMENT "PARAMETER" or "RESULT" (for OPERATION and ERROR) is always optional from a syntactic point of view. However, except specific mention, it has to be considered as mandatory from a semantic point of view. When in an invoke component, a mandatory element is missing in any component or inner data structure, a reject component is returned with the problem code "Mistyped Parameter". When an optional element is missing in an invoke component or in an inner data structure while it is required by the context, an error component is returned; the associated type of error is "DataMissing".

In case an element is defined as mandatory in the protocol description (GSM 04.71 including imports from GSM 09.02), but is not present according to the service description (stage 1 to stage 3), the ASN.1 protocol description takes precedence over the diagrams in the GSM 04.8x and 04.9x-series of technical specifications.

When possible operations and errors are imported from GSM 09.02 thereby making the MSC transparent to most of the messages sent to or from the LMU.

Timer values for operations which require timers are shown as ASN.1 comments.

Ellipsis Notation shall be used in the same way as described in GSM 09.02 and shall be supported on the radio interface by the LMU and the network for all operations defined in this specification including those imported from GSM 09.02.

9.2 Operation types

Table 7.1 summarizes the operations defined for LMU LCS Protocol ~~location services~~ in this specification, and shows which of these operations are Radio Interface Timing (RIT) related, Time Of Arrival (TOA) location method related, and general LMU procedures related. In this ASN.1 module, ASN.1/88 defined in CCITT X.208 recommendations (ASN.1 1988) is used.

Table 7.1: Relevance of location service operations

Operation name	Direction	Response allowed	RIT	TOA	General LMU
StartRIT	SMLC -> LMU	ReturnResult (empty) .	X		
ReportRIT	LMU -> SMLC	No	X		
StopRIT	SMLC -> LMU	ReturnResult (empty).	X		
IndicateRITError	LMU -> SMLC	No	X		
PerformTOA	SMLC -> LMU	ReturnResult		X	
~~StatusRequest~~StatusQuery	SMLC -> LMU	ReturnResult			X
StatusUpdate	LMU -> SMLC	ReturnResult (empty)			X
ResetRequest	SMLC -> LMU	ReturnResult (empty).			X
OMRequest	SMLC -> LMU	ReturnResult			X
OMReport	LMU -> SMLC	ReturnResult			X

This specification defines the following operations (transparent to MSC):

- StartRIT
- ReportRIT
- StopRIT
- IndicateRITError
- PerformTOA
- ~~StatusRequest~~StatusQuery
- StatusUpdate
- ResetRequest
- OMRequest
- OMReport

```
-- LLPCS-Operations module defines the operations transparent to MSC

LLPCS-Operations
-- { LLPCS-Operations object identifier }

DEFINITIONS ::=

BEGIN


IMPORTS
   OPERATION
FROM TCAPMessages {
   ccitt recommendation q 773 modules (2) messages (1) version2 (2)}

      SystemFailure,
   DataMissing,
   UnexpectedDataValue,
   FacilityNotSupported,
   UnknownSubscriber,
FROM MAP-Errors {
   ccitt identified-organization (4) etsi (0) mobileDomain (0)
   gsm-Network (1) modules (3) map-Errors (10) version4 (4)}


   UnDefinedError
FROM LLPCS-Errors
-- {}

      StartRITReq,
   ReportRITRsp,
      ErrorRITRsp,
   PerformTOAReq,
   TOAResultRsp,
   StatusReq,
```

```
   StatusRsp,
   ResetReq,
   OMREQ-REP,
   StatusRep
OMRequest,
   OMRequestRsp,
   OMReport,
   OMReportRsp
FROM -LLPCS-DataTypes {
   ccitt identified-organization (4) etsi (0) mobileDomain (0)
   gsm-Network (1) modules (3) map-LCS-DataTypes (n) version4 (4)}
;

-- OPERATION definitions based on macro notation
```

```
StartRIT::= OPERATION      -- identifier StartRIT-Measurement
   ARGUMENT
      startRITReq     StartRITReq
   RESULT
      startRITRsp     StartRITRsp
   ERROR {

   SystemFailure,
   DataMissing,
   UnexpectedDataValue,
   ResourcesNotAvailable,
   UnDefinedError
   }
```

```
ReportRIT::= OPERATION     -- identifier ReportRIT-Measurement
   ARGUMENT
      reportRITrsp       ReportRITRsp
```

```
StopRIT::= OPERATION    -- identifier StopRIT-Measurement
   ARGUMENT
      stopRITReq       StopRITReq
   RESULT
      StopRITRsp       StopRITRsp
```

```
IndicateRITError ::= OPERATION
   ARGUMENT
      errorRITRsp     ErrorRITRsp
```

```
PerformTOA::= OPERATION    -- identifier PerformTOA-Measurment
   ARGUMENT
      performTOAReq      PerformTOAReq
   RESULT
      toaResultRsp       TOAResultRsp
   ERROR {
   SystemFailure,
   DataMissing,
   UnexpectedDataValue,
   ResourcesNotAvailable,
   UnDefinedError
   }
```

```
StatusRequestStatusQuery::= OPERATION
   ARGUMENT
      statusReq          StatusReq
   RESULT
      statusRsp          StatusRsp
   ERROR {
   }
```

```
ResetRequest::= OPERATION
   ARGUMENT
      resetReq        ResetReq
   RESULT
      resetRsp        ResetRsp
   ERROR {
   SystemFailure,
   UnDefinedError
   }
```

```
OMRequest ::= OPERATION        -- identifier O&M Request
   ARGUMENT
      OMRequestomRequest         OMREQ-REP
   RESULT
      OMRequestRspomRequestRsp      OMREQ-REP
   ERROR {
   SystemFailure,
   DataMissing,
   UnexpectedDataValue,
   ResourceNotAvailable,
   UnDefinedError
}
```

```
OMReport ::= OPERATION         -- identifier O&M Report
   ARGUMENT
      OMRequestomRequest         OMREQ-REP
   RESULT
      OMRequestRspomRequestRsp      OMREQ-REP
   ERROR {
   SystemFailure,
   DataMissing,
   UnexpectedDataValue,
   ResourceNotAvailable,
   UnDefinedError
}
```

```
StatusUpdate ::= OPERATION     -- identifier Status Update
   ARGUMENT
      statusUpdateReq         StatusUpdateReq
   RESULT
      statusUpdateRsp         StatusUpdateRsp
   ERROR {
   SystemFailure,
   DataMissing,
   UnexpectedDataValue,
   ResourceNotAvailable,
   UnDefinedError
}
```

```
END
```

9.2.1 Operation types description

For each operation type this subclause provides a brief prose description.

9.2.1.1 StartRIT (network --> LMU)

This operation type is invoked by the network to request RIT measurement information from an LMU.~~If a single RIT measurement is asked for, the measurement results can be returned using the return result component of the operation.~~

9.2.1.2 ReportRIT (LMU -->network)

This operation type is invoked by an LMU to report to the network RIT measurement information. This operation is used to report periodical measurements.

9.2.1.3 StopRIT (network --> LMU)

This operation type is invoked by the network to request an LMU to stop on-going RIT measurements and reporting.

9.2.1.4 IndicateRITError (LMU --> network)

This operation type is invoked by an LMU to indicate error situations.

9.2.1.5 PerformTOA (network --> LMU)

This operation type is invoked by the network to request an LMU to perform TOA location mesurements. The measurement results are returned using the return result component of the operation.

9.2.1.6 StatusRequestStatusQuery (network --> LMU)

This operation type is invoked by the network to request status an LMU The status is returned using the return result component of the operation.

9.2.1.7 StatusUpdate (LMU --> network)

This operation type is invoked by an LMU to report status of LMU, e.g. after reset or periodically.

9.2.1.87 ResetRequest (network --> LMU)

This operation type is invoked by the network to reset an LMU.

9.2.1.98 OMRequest (network --> LMU)

This operation type is invoked by the network to request a specific O&M activity to LMU

9.2.1.109 OMReport (LMU -> network)

This operation type is invoked by the LMU to report an O&M event to Network or asking for reporting O&M information from Network.

10.3 Error types

10.3.1 Error types ASN.1 specification

The following ASN.1 module provides an ASN.1 specification of errors. Errors from MAP are imported in the LCS-Protocol module in subclause 9.2. In this ASN.1 module, ASN.1/88 defined in CCITT X.208 recommendations (ASN.1 1988) is used.

```
LLPCS-Errors
-- { LLPCS-Errors object identifier }

DEFINITIONS ::=

BEGIN

IMPORTS

ERROR FROM
TCAPMessages FROM {
   ccitt recommendation q 773 modules (2) messages (1) version2 (2) }
;

-- The MAP errors

-- error types definition
UnDefinedError ::=ERROR

END
```

10.3.2 Error types description

For each error type this subclause provides a brief prose description.

10.3.2.4 SystemFailure

This error is returned by the LMU or the network, when it cannot perform an operation because of a failure.

10.3.2.5 DataMissing

This error is returned by the network or the LMU when an optional parameter is missing in an invoke component or an inner data structure, while it is required by the context of the request.

10.3.2.6 UnexpectedDataValue

This error is returned by the network or the LMU when it receives a parameter with an unexpected value, without type violation.

10.3.2.7 ResourcesNotAvailable

This error is returned by the network or the LMU if temporarily there are no resources.

10.3.2.9 UnDefinedError

This error is returned by the LMU or the network when any other error type is not applicable.

10.4 Operations and errors implementation

For the actual implementation of location services, operations and errors have to be defined by value. The following ASN.1 module, imports operation types from the ASN.1 module described in subclause 9.2 and operation and error types from MAP. It defines operations by allocating operations and errors a local value. For the involved operations and errors the same local values as in MAP are allocated. In this ASN.1 module, ASN.1/88 defined in CCITT X.208 recommendations (ASN.1 1988) is used.

```
LLPCS-Protocol
-- { LLPCS-Protocol object identifier }

DEFINITIONS ::=

BEGIN

IMPORTS

      SystemFailure,
   DataMissing,
   UnexpectedDataValue,
   FacilityNotSupported,
   UnknownSubscriber,
FROM MAP-Errors {
   ccitt identified-organization (4) etsi (0) mobileDomain (0)
   gsm-Network (1) modules (3) map-Errors (10) version4 (4)}


   UnDefinedError
FROM LLPCS-Errors
-- { LLPCS-Errors object identifier }

      StartRIT,
   ReportRIT,
   StopRIT,
      IndicateRITError,
   PerformTOA,
   StatusRequestStatusQuery,
   ResetRequest,
   OMRequest,
   OMReport,
   StatusUpdate
FROM --LLPCS-Operations
-- { LLPCS-Operations object identifier }
-- allocate local values for errors

systemFailure  SystemFailure ::= localValue 10
dataMissing    DataMissing ::= localValue 11
unexpectedDataValue  UnexpectedDataValue ::= localValue 12
facilityNotSupported FacilityNotSupported ::= localValue 13
unknownSubscriber    UnknownSubscriber ::= localValue 14
unDefinedError UnDefinedError ::= localValue 50

startRIT StartRIT ::= localValue 10
reportRIT   ReportRIT ::= localValue 11
stopRIT  StopRIT ::= localValue 12
indicateRITError  IndicateRITError ::= localValue 13
performTOA  PerformTOA ::= localValue 20
statusRequeststatusQuery   StatusRequestStatusQuery ::= localValue 30
resetRequest   ResetRequest ::= localValue 31
omRequest   OMRequestOMRequest   OM_REQ_REP ::= LocalValue 32
omReport OMReportOMReport  OM_REQ_REP ::= LocalValue 33
StatusUpdate   StatusUpdate ::= LocalValue 34

END
```

11 LMU LCS Protocol (LLP) MLC-LMU messages

11.1 Messages, data types and identifiers

11.1.1 General

This clause defines the External Signal Info IE, that contains Signal Info string. Signal Info string contains the MLC-LMU messages defined by ASN.1 and coded by PER (X.691). In this ASN.1 module, ASN.1/94 defined in ITU-T X.680 recommendations (ASN.1 1994) is used.

11.1.2 ASN.1 data types

```
LLPCS-DataTypes
-- { LLPCS-DataTypes object identifier }

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS

ExtensionContainer

FROM MAP-ExtensionDataTypes {

   ccitt identified-organization (4) etsi (0) mobileDomain (0)

   gsm-Network (1) modules (3) map-ExtensionDataTypes (21) version4 (4)}


;

StartRITReq ::= SEQUENCE {
   rit-MeasurementType     RIT-MeasurementType,
   rit-ReliabilityInfo     RIT-ReliabilityInfo,
   rit-ReportingType       RIT-ReportingType,
   rit-RequestedQuality    RIT-ReferenceQuality,
   rit-Environment         RIT-Environment,
   rit-NeigborNumber       RIT-NeighborNumber,
   rit-NeighborType        RIT-NeighborType,
   rit-CIMethod         CIMethod,
   rit-BTSInfo          RIT-BTSInfo       OPTIONAL,
   extensionContainer      ExtensionContainer   OPTIONAL,
   ...
}

StartRITRsp ::= SEQUENCE {
   extensionContainer      ExtensionContainer   OPTIONAL,
   ...
}

StopRITReq ::= SEQUENCE {
extensionContainer      ExtensionContainer   OPTIONAL,
   ...
}

StopRITRsp ::= SEQUENCE {
extensionContainer      ExtensionContainer   OPTIONAL,
   ...
}

ReportRIT ::= SEQUENCE {
   rit-ReferenceIDInfo  RIT-ReferenceIDInfo,
   rit-ResponseInfo SET (SIZE(0..1531)) OF RIT-ResponseInfo,
   extensionContainer      ExtensionContainer   OPTIONAL,
   ...
```

```
}

StatusReq ::= SEQUENCE {
   eExtensionContainer     ExtensionContainer   OPTIONAL,
   ...
}

StatusRsp ::= SEQUENCE {
   statusTime          StatusTime,
   rit-Status          RIT-Status,
   toa-Status          TOA-Status,
   omStatus         OMStatus,
   extensionContainer     ExtensionContainer   OPTIONAL,
   ...
}

ErrorRITRsp ::= SEQUENCE {
   rit-ErrorType       RIT-ErrorType,
   rit-ErrorReason        RIT-ErrorReason,
   extensionContainer     ExtensionContainer   OPTIONAL,
   ...
   }

PerformTOA ::= SEQUENCE {
   toa-MeasurementDeviceInfo  TOA-MeasurementDeviceInfo,
   toa-ChannelDescr        TOA-ChannelDescr,
   toa-SignalDescr         TOA-SignalDescr,
   toa-TimingDescr         TOA-TimingDescr,
   toa-MeasurementOpt      TOA-MeasurementOpt   OPTIONAL,
   extensionContainer      ExtensionContainer   OPTIONAL,
   ...
}



TOAResultRsp ::= SEQUENCE {
   toa-TimingReferenceInfo    TOA-TimingReferenceInfo,
   toa-Measurements        TOA-MeasurementInfo,
   extensionContainer      ExtensionContainer   OPTIONAL,
   ...
}

OMREQ-REP ::= SEQUENCE {
      omData           OM-Data        OPTIONAL,
      extensionContainer      ExtensionContainer   OPTIONAL,
      ...
}
StatusUpdateReq ::= SEQUENCE {
   statusReason               StatusReason,
   statusTime                 StatusTime,
   ritStatus                  RIT-Status,
   toaStatus                  TOA-Status,
   omStatus                   OMStatus,
   extensionContainer      ExtensionContainer   OPTIONAL,
      …
}


StatusUpdateRsp ::= SEQUENCE {
extensionContainer      ExtensionContainer   OPTIONAL,
   ...
}

ResetReq ::= SEQUENCE {
extensionContainer      ExtensionContainer   OPTIONAL,
   ...
}

ResetRsp ::= SEQUENCE {
extensionContainer      ExtensionContainer   OPTIONAL,
   ...
}

-- DATA TYPES DEFINITION

OM-Data ::= OCTET STRING (SIZE(1..244))

-- RIT measurement Type information
```

```
RIT-MeasurementType ::= INTEGER {
   atdMeasure (0),
   atdOrOtdMeasure (1),
   rtdMeasure (2)
} (0..7)

-- RIT Reliability Information
RIT-ReliabilityInfo ::= SEQUENCE {
   rit-ReliabilityFormat      ValueUnit,
   rit-Reliability         RIT-Reliability
}

ValueUnit ::= INTEGER {
   tensOfMeters (0),
   hundredsOfMeters (1)
} (0..3)

RIT-Reliability ::= INTEGER (1..63)

-- RIT Reporting Type information
RIT-ReportingType ::= SEQUENCE {
   rit-ReportingPeriodInfo    RIT-ReportingPeriodInfo OPTIONAL,
   rit-ChangeLimit         ChangeLimit       OPTIONAL,
   rit-DeviationLimitInfo     RIT-DeviationLimitInfo  OPTIONAL
}

RIT-ReportingPeriodInfo ::= SEQUENCE {
   rit-ReportingPeriodFormat  ValueUnit,
   rit-ReportingPeriod     ReportingPeriod
}

ReportingPeriod ::= INTEGER (1..120)

ChangeLimit ::= INTEGER (1..255)

RIT-DeviationLimitInfo ::= CHOICE {
   rit-DeviationLimit      RIT-DeviationLimit,
   rit-MonitorPeriodInfo   RIT-MonitorPeriodInfo
}

RIT-DeviationLimit ::= SEQUENCE {
   rit-DeviationLimit      DeviationLimit,
   rit-MonitorPeriod       MonitorPeriod
}

RIT-MonitorPeriodInfo ::= SEQUENCE {
   monitorPeriod           MonitorPeriod  OPTIONAL
}


DeviationLimit ::= INTEGER (1..255)

MonitorPeriod::= INTEGER (1..64)

RIT-ReferenceQuality ::= INTEGER {
   stdTOA-tensofMeters (0),
   stdTOA-hundredsofMeters (1),
   snrEstimate (2),
   undefinedRelativeQuality (3)
} (0..7)

-- RIT Environment Information
RIT-Environment ::= INTEGER {
   heavyMultiPathAndNLOS (0),
      -- bad urban or urban heavy multipath and NLOS conditions
   lightMultiPathAndLOS (1),
      -- suburban or rural ligth multipath and LOS conditions
   mixedEnvironement (2)
      -- not defined or mixed environment

} (0..7)


RIT-NeighborNumber ::= INTEGER (0..1531)

RIT-NeighborType ::= INTEGER {
   listedNeighbors (0),
   listedAndSystemInfo2or5 (1),
   systemInfoType2or5 (2),
```

```
   allNeighbors (3)
} (0..7)

CIMethod ::= INTEGER {
   notCi (0),  -- report ci and carrier instead of CI
   ci (1)      -- report CI if possible
} (0..3)

-- element contains information of base stations
-- to be measured
RIT-BTSInfo ::= SEQUENCE {
   rit-BTSList SET (SIZE(1..31)) OF RIT-BTSList -- list of btss
}

RIT-BTSList ::= SEQUENCE {
   rit-ListCi     CI,
   rit-TimeSlotScheme      TimeSlotScheme,
   rit-ListBSIC         BSIC,
   rit-ListBCCHCarrier     BCCHCarrier
}

CI ::= INTEGER (0..65535)

TimeSlotScheme ::= INTEGER {
   schemeUnknown (0),
   equalLength    (1),
   variousLength (2)
} (0..7)

BSIC ::= INTEGER (0..63)

BCCHCarrier ::= INTEGER (0..1023)

RIT-ReferenceIDInfo ::= SEQUENCE {
   rit-ReferenceLAC        LAC,        -- defined earlier
   rit-ReferenceCI         CI,         -- defined earlier
   rit-ReferenceFrameNbr      FrameNumber,   -- defined earlier
   rit-ResponseType        RIT-ResponseType,
   rit-ReferenceTimeSlot      TimeSlot,      -- defined earlier
   rit-ReferenceRXLevel    RXLevel,    -- defined earlier
   rit-ReferenceQuality    RIT-ReferenceQualityType
}

RIT-ResponseType ::= CHOICE {
   rit-NoATReference       RIT-NoATReference,
   rit-ATReference         RIT-ATReference
}

RIT-NoATReference ::= NULL

RIT-ATReference ::= SEQUENCE {
   rit-CommonClock         CommonClock,
   rit-ReferenceATValue    ReferenceATValue,
   rit-ReferenceATChange      ATChange
}

RIT-ReferenceQualityType ::= SEQUENCE {
   qualityType          RIT-ReferenceQuality,
   referenceQuality        ReferenceQuality
}

ReferenceQuality ::= INTEGER (0..64)

-- Measured RTD values from one neighbor
RIT-ResponseInfo ::= SEQUENCE {


   rit-NeighborCellIDInfo     RIT-CellIDInfo,
   rit-NeighborTimeSlot    TimeSlot,
   rit-NeighborRxLevel     RXLevel,
   rit-NeighborFrameNumber    FrameNumber    OPTIONAL,
   rit-NeighborQuality     MeasurementQuality,
   rit-NeighborATDRTD      ATDRTD,
   rit-NeighborATDRTDChange   ATDRTDChange
}

RIT-CellIDInfo ::= CHOICE {
   rit-NeighborCI       CI,
   rit-NeighborBTS         RIT-NeighborBTS
```

```
}

RIT-NeighborBTS ::= SEQUENCE {
   rit-NeighborBSIC        BSIC,
   rit-NeighborBCCHCarrier    BCCHCarrier
}

FrameNumber ::= INTEGER (0..2715647)

LAC ::= INTEGER (0..65535)

CommonClock ::= INTEGER {
   gpsClock    (0),
   glonass  (1)
} (0..7)

ReferenceATValue ::= INTEGER (0..159999999999)

ATDRTD ::= INTEGER (0..923200)

ATChange ::= INTEGER (-1000..1000)

TimeSlot ::= INTEGER (0..7)

RXLevel ::= INTEGER (0..63) -- range -150 to -24 with 2dBm steps

MeasurementQuality ::= INTEGER (0..64)

ATDRTDChange ::= INTEGER (-1000..1000)


-- STATUS ELEMENTS

StatusReason ::= ENUMERATED {
   powerUp (0),              -- no knowledge about previous states
   unsucSWReset (1),         -- unsuccessful recovery
   sucSWReset (2),           -- successful recovery
   unknownError (3),         -- unknown selfdiagnosis error
   unrelTBError (4),         -- unreliable timebase error
   periodicReport (5),       -- periodic status report
   …
}

StatusTime ::= SEQUENCE {
   referenceLAC         LAC,     -- defined earlier
   referenceCI          CI,      -- defined earlier
   referenceFrameNumber    FrameNumber -- defined earlier
}

RIT-Status ::= RIT-Jobs

RIT-Jobs ::= INTEGER (0..63)

TOA-Status ::= TOA-Jobs

TOA-Jobs ::= INTEGER (0..63)

OMStatus ::= OMJobs

OMJobs ::= INTEGER (0..63)    -- Range: FFS

-- ERROR RIT ELEMENTS

RIT-ErrorType ::= INTEGER {
   permament (0),
   temporary (1)
} (0..3)

RIT-ErrorReason ::= INTEGER {


   noNeighbors (0),
   noReferenceClock (1),
   notSupportedType (2),
   undefinedError (3)
} (0..15)


-- TOA DEFINITIONS
```

```
-- MEASUREMENTDEVICE INFORMATION
TOA-MeasurementDeviceInfo ::= SEQUENCE {
   measurementDeviceList SET (SIZE(1..86)) OF TOA-LMUMeasurementDevice
      -- list of measurement devices
}

TOA-LMUMeasurementDevice ::= INTEGER (0..75)


-- CHANNEL DESCRIPTION
TOA-ChannelDescr ::= SEQUENCE {
   toa-FrequencyListType      TOA-FrequencyListType,
   toa-hoppingUsed         TOA-HoppingUsed   OPTIONAL,
   toa-channelType         TOA-ChannelType,
   toa-numberOfBursts      TOA-NumberOfBurst
}

TOA-FrequencyListType ::= CHOICE {
   frequencyListOnly       FrequencyListOnly,
   frequencyListAndIndex      FrequencyListAndIndex,
   frequencyIndexOnly      FrequencyIndexOnly
}

FrequencyListOnly ::= SEQUENCE {
   toa-arfcnList SET (SIZE(1..64)) OF TOA-ARFCNumber
               -- list of channels
}

FrequencyListAndIndex ::= SEQUENCE {
   toa-arfcnList SET (SIZE(1..64)) OF TOA-ARFCNumber,
               -- list of channels
   frequencyIndex          FrequencyIndex
}

FrequencyIndexOnly ::= SEQUENCE {
   frequencyIndex          FrequencyIndex
}

FrequencyIndex ::= INTEGER (0..31)


TOA-ARFCNumber ::= BCCHCarrier   -- defined earlier

TOA-HoppingUsed ::= CHOICE {
   hoppingOn            TOA-Hopping,
   hoppingOff           NULL
}

TOA-Hopping ::= SEQUENCE {
   toa-maio          MAIO,
   toa-hsn           HSN,
   toa-MsframeNumber    ModuloFrameNumber
}

MAIO ::= INTEGER (0..63) -- Mobile Allocation Index Offset

HSN ::= INTEGER (0..63) -- Hopping Sequence Number

ModuloFrameNumber ::= INTEGER (0..84863)

TOA-ChannelType ::= INTEGER {
   tchf(0),


   tchhscn0 (1),
   tchhscn1 (2)
} (0..7)

TOA-NumberOfBurst ::= INTEGER (0..7)


-- SIGNAL DESCRIPTION
TOA-SignalDescr ::= SEQUENCE {
   toa-BurstType        TOA-BurstType
}

TOA-BurstType ::= CHOICE {
   toa-AccessBurst         TOA-AccessBurst,  -- access burst
```

```
   toa-TSC           TSC         -- normal burst
}

TOA-AccessBurst ::= SEQUENCE {
   toa-HOReference        HOReference,
   toa-BSIC          BSIC  -- defined earlier
}

HOReference ::= INTEGER (0..255)

TSC ::= INTEGER (0..7)


-- TIMING DESCRIPTION

TOA-TimingDescr ::= SEQUENCE {
   toa-TimeReference      TOA-TimeReference,
   toa-timeUncertainty    TimeUncertainty
}

TOA-TimeReference ::= CHOICE {
   toa-gpsTime         TOA-GPSTime,
   toa-gsmStartTime       TOA-GSMStartTime
}

TOA-GPSTime ::= SEQUENCE {
   toa-GPSStartTime       GPSStartTime,
   toa-GPSSV           GPSSV

}

GPSStartTime ::= INTEGER (0..14999999) -- unit is microseconds

GPSSV ::= INTEGER (0..31)

TOA-GSMStartTime ::= SEQUENCE {
   toa-arfcn           BCCHCarrier,   -- defined earlier
   toa-bsic          BSIC,    -- defined earlier
   toa-GSMStartTime  GSMTime
}

GSMTime ::= SEQUENCE {
   toa-GSMTimeframeNumber    GSMTimeFrameNumber,
   toa-timeSlot        TimeSlot,
   toa-bitNumber       BitNumber
}

GSMTimeFrameNumber ::= INTEGER (0..42323)

BitNumber ::= INTEGER (0..156)

TimeUncertainty ::= INTEGER (0..15)


-- MEASUREMENT OPTIONS

TOA-MeasurementOpt    ::= SEQUENCE {


   toa-LMUMethod       TOA-Method,
   toa-Environment        TOA-Environment,
   toa-MeasurementType    TOA-MeasurementType
}

TOA-Method ::= INTEGER (0..7)

TOA-Environment ::= INTEGER {
   heavyMpathAndNLOS (0),
   lightMpathAndLOS (1),
   mixed (2)
} (0..7)

TOA-MeasurementType ::= INTEGER {
   reportTOA-only (0),
   reportAOA-only (1),
   reportTOAandAOA (2)
} (0..3)
```

```
-- TIMING INFO

TOA-TimingReferenceInfo ::= CHOICE {
   toa-GPSTimeInfo        NULL,
   toa-GSMTimeInfo        TOA-GSMTimeInfo
}

TOA-GSMTimeInfo ::= SEQUENCE {
   toa-bcch          BCCHCarrier,   -- defined earlier
   toa-bsic          BSIC     -- defined earlier
}


-- THE ACTUAL TOA MEASUREMENTS

TOA-MeasurementInfo ::= SEQUENCE {
   toaMeasurements SET (SIZE(1..68)) OF TOA-Measurements
      -- list of measurementDevices
}

TOA-Measurements  ::= SEQUENCE {
   toa-MeasurementDeviceID    MeasurementDeviceID,
   toa-AddMeasurementInfo     TOA-AddMeasurementInfo,
   toa-measuredPeakList    TOA-MeasuredPeakList
}


-- MEASUREMENT DEVICE ID IE

MeasurementDeviceID ::= INTEGER (0..57)


-- MEASUREMENT INFO IE IN RESULT MESSAGE

TOA-AddMeasurementInfo ::= SEQUENCE {
   toa-Method           TOA-Method,          -- defined earlier
   toa-Diversity        TOA-Diversity,
   toa-NumberOfBurst       TOA-NumberOfBurst,      -- defined earlier
   toa-AOA           TOA-AOA        OPTIONAL,
   toa-AOAUncertainty      TOA-AOAUncertainty   OPTIONAL
}

TOA-Diversity ::= INTEGER {
   noDiversity (0),
   diversity (1)
} (0..3)


TOA-AOA ::= INTEGER (0..3599)

TOA-AOAUncertainty ::= INTEGER (0..31)


-- PEAKS LIST OF MEASURED TOAs

TOA-MeasuredPeakList ::= SEQUENCE {
   toa-measuredPeaks SET (SIZE(0..47)) OF TOA-MeasuredPeaks
      -- list of peaks
}


-- MEASURED TOA IE

TOA-MeasuredPeaks ::= SEQUENCE {
   toa-MeasuredTOA         MeasuredTOA,
   toa-QualityInfo         TOA-QualityInfo
}

MeasuredTOA ::= INTEGER (-131072..131071)
   -- the absolute TOA value

TOA-QualityInfo ::= SEQUENCE {
   toa-Uncertainty         TOA-Uncertainty      OPTIONAL,
   snrEstimate          SNREstimate       OPTIONAL,
   toaSignalStrength       TOASignalStrength    OPTIONAL
}

TOA-Uncertainty ::= INTEGER (0..63)
   -- the uncertainty of the TOA estimate
```

```
SNREstimate ::= INTEGER (-30..33)
   -- the estimated value for Signal Noise Radio

TOASignalStrength ::= INTEGER (0..63)
   -- range -150 to -24 with 2dBm steps

END



-- The definition below will be imported from MAP specification.
--
--
-- MAP-ExtensionDataTypes {
--   ccitt identified-organization (4) etsi (0) mobileDomain (0)
--   gsm-Network (1) modules (3) map-ExtensionDataTypes (21) version4 (4)}
--
-- DEFINITIONS
--
-- IMPLICIT TAGS
--
-- ::=
--
-- BEGIN
--
-- EXPORTS
--
-- PrivateExtension,
-- ExtensionContainer;
--
--
--
-- MAP-EXTENSION  ::= CLASS {
-- &ExtensionType          OPTIONAL,
-- &extensionId   OBJECT IDENTIFIER }
-- -- The length of the Object Identifier shall not exceed 16 octets and the
-- -- number of components of the Object Identifier shall not exceed 16
--
--
--
-- data types
--
-- ExtensionContainer ::= SEQUENCE {
-- privateExtensionList [0]PrivateExtensionList OPTIONAL,
-- pcs-Extensions [1]PCS-Extensions OPTIONAL,
-- ...}
--
-- PrivateExtensionList ::= SEQUENCE SIZE (1..maxNumOfPrivateExtensions) OF
--          PrivateExtension
--
-- PrivateExtension ::= SEQUENCE {
-- extId    MAP-EXTENSION.&extensionId
--          ({ExtensionSet}),
--
-- extType     MAP-EXTENSION.&ExtensionType
--          ({ExtensionSet}{@extId})  OPTIONAL}
--
-- maxNumOfPrivateExtensions  INTEGER ::= 10
--
-- ExtensionSet      MAP-EXTENSION ::=
--    {...
--     -- ExtensionSet is the set of all defined private extensions
-- }
--
-- Unsupported private extensions shall be discarded if received.
--
--
-- PCS-Extensions ::= SEQUENCE {
-- ...}
--
-- END
```

11.1.3 Identifiers definition

In the informative annexes the contents of the identifiers used in operation and error types description are further discussed.

Annex A (informative): RIT messages

A.1 Introduction

This annex describes the contents of Radio Interface Timing (RIT) related messages.

A.2 Messages

The messages below are considered to be transported between the SMLC and the LMU.

A.2.1 RIT Measurement Request Message

The RIT Measurement Request is a message from the SMLC to the LMU. As a response to it the LMU performs Real Time Difference (RTD) or Absolute Time Difference (ATD) measurements. It contains the following information elements.

Table 1. RIT Measurement Request message content.

Information element	*Type/Reference*	*Presence*
Message Type	Message Type A.2.1.1.1	M
Measurement Instructions	Measurement Instructions A.2.1.1.2	M
BTS List	BTS List A.2.1.1.3	C

A.2.1.1 RIT Measurement Request Message Information Elements

A.2.1.1.1 Message Type IE

This IE contains the type of the message. This IE is mandatory.

A.2.1.1.2 Measurement Instructions IE

The purpose of the Measurement Instructions IE is to inform the LMU about the measurement type (RTD/ATD), measurement result reporting rate, and tell which BTSs should be measured. This IE is mandatory, and it contains the following fields:

Measurement Type

This field indicates whether AT of reference BTS is required.

'0': AT of reference BTS should be reported. If AT of reference BTS can not be measured, no ATD/RTD measurements are reported.

'1': AT of reference BTS should be reported . If AT of reference BTS can not be measured, ATD/RTD measurements are reported anyhow.

'2': ATD/RTD measurements timestamped with frame number of the reference BTS should be performed.

Reliability Format

This field describes the units of the Reliability field.

‘0’: Reliability is told in tens of meters.

‘1’: Reliability Period is told in hundreds of meters.

Reliability

This field indicates what is the desired 90 % RIT reliability.

Range: 1 – 63

Note: Name and definiton of this field are FFS.

Reporting Period Format

This field describes the units of the Reporting Period field. This field is optional. If this field is included, RIT Measurement Responses shall be send with the period indicated in this and Reporting Period fields.

‘0’: Reporting Period is told in tens of seconds.

‘1’: Reporting Period is in tens of minutes.

Reporting Period

This field describes the value for the reporting period, i.e. the required time period between the RIT Measurement Response messages. Its units and multiplication factor are defined in the Reporting Period Format field. This field is conditional and included only if the Reporting Period Format is included.

Range: 0-120

Change Limit

This field indicates the limit for the change of AT or ATD /RTD values in units of 0.02 micro-seconds. If any AT or ATD/RTD value has changed more than the value in this field since the last RIT Measurement Response, a new RIT Measurement Response message is sent. This field is optional. If this field is included, RIT Measurement Responses shall be send when some RIT value has changed more than this limit.

Range: 1-255

Deviation Limit

This field indicates the limit for the deviation of the AT or ATD/RTD values. If any time the predicted AT or ATD/RTD value (based on reported AT or ATD/RTD values and changes in the last RIT Measurement Response) has deviated more than the value in this field compared to the current measurement result, a new RIT Measurement Response message is sent. This field is optional. If this field is included, RIT Measurement Responses shall be send when the first deviation of some RIT value is more than this limit. The values are in units of 0.02 micro-seconds.

Range: 1-255

Note: Predicted AT or ATD/RTD value means the value that is calculated (extrapolated) based on AT or ATD/RTD value and AT or ATD/RTD Change value in last RIT Measurement Response message.

Monitor Period

This field indicates the requested time period for monitoring the time derivative of AT or ATD/RTD values, i.e. on how long monitor period the reported AT or ATD/RTD change is based. The value is in tens of seconds. This field conditional and included if Deviation Limit field is included or this field may be included optionally if RTD or ATD change is requested to be reported in RIT Measurement Response message.

Range: 1- 64

Requested Quality Type

Requested Quality Type field defines the quality type that should be used in RIT Measurement Response message in Reference Quality and Neighbor Quality fields.

‘0’: Std of TOA measurements in tens of meters.

‘1’: Std of TOA measurements in hundreds of meters.

‘2’: SNR estimate.

‘3’: Undefined relative quality value.

‘4’: Reserved.

Environment Characterization

Environment Characterization field gives a LMU information about expected multipath and NLOS in the area.

‘0’: possibly heavy multipath and NLOS conditions (e.g. bad urban or urban)

‘1’: no or light multipath and usually LOS conditions (e.g. suburban or rural)

‘2’: not defined or mixed environment

‘3’: reserved

‘4’: reserved (i.e. several values should be reserved)

Neighbor Number

This field indicates the maximum number of neighbor BTSs that the LMU should try to report.

Range: 0-15~~31~~

Neighbor Type

This field indicates which neighbor BTSs are used for RIT measurements. If the value of the Neighbor Number field is lower than the total number of BTSs in the required list, then the BTS are selected in the order of the list.

‘0’: Neighbor BTSs listed in the BTS List IE are used for RIT measurements in the order of the list.

‘1’: If possible, neighbor BTSs listed in the BTS List IE are used, otherwise neighbors received in SYSTEM INFORMATION 2 or 5 message are used in the order of received signal strength.

‘2’: Neighbor BTSs indicated in SYSTEM INFORMATION TYPE 2 or 5 are used for RIT measurements (i.e. this is normal operation) in the order of received signal strength.

‘3’: All neighbor BTSs that can be received (i.e. reported BTSs are not limited to BTSs listed in SYSTEM INFORMATION TYPE 2 or 5 or BTS List IE). Support of this option in LMU is optional.

CellIdMethod

CellIdMethod field indicates whether CI or BSIC and BCCH carrier is used to identify neighbor BTSs in RIT Measurement Responses.

‘0’ = BSIC and BCCH carrier are used to identify the cell, even if CI is available.

‘1’ = CI is used to identify the neighbor cell, if it is available, otherwise BSIC and BCCH carrier are used.

A.2.1.1.3 BTS List IE

This information element indicates neighbor BTSs that are used for RIT measurements. This IE is conditional. If Neighbor Type field in the Measurement Instructions IE is ‘0’ or ‘1’ this field must be included. The first BTS on the list is the reference BTS that should be used as reference when reporting the RTD or AT values. If this reference BTS is not available, the LMU can select the used reference BTS based on signal strength.

This IE contains the following fields.

Number of BTSs

This field indicates, how many BTSs are included in this IE.

Range: 1 to 31.

The following fields are repeated the number of times included in Number of BTSs field.

CI

This field indicates the Cell Identity of the particular BTS. The purpose of the Cell Identity value is to identify a BTS within a location area.

Range: 0 - 65535

Note: Here is assumed that when LMU starts to make measurements, it firsts goes to the requested frequencies, and starts to decode BSICs and CIs from those specific frequencies. Because of this procedure the risk that there would be two BTSs with same CIs and same Channel numbers is minimal (i.e. there is no need to transmit LAC).

Time Slot Scheme

The Time Slot Scheme field indicates what kind of transmission scheme the particular BTS is using. If the LMU measures signals from BTSs from other time slots than 0 or 4, and it is informed about the burst length schemes used by BTSs, then it can compensate for the possible error. (This is necessary if the LMU averages bursts from different time slots, and the BTS uses varying lengths of bursts.)

‘0’ = the burst scheme is unknown (The time slot should remain the same)

‘1’ = all time slots are 156.25 bits long

‘2’ = time slots 0 and 4 are 157 bits long and other time slots are 156 bits long

BSIC

This field indicates the BSIC (Base Station Identity Code) of the particular BTS.

Range: 0 - 63

BCCH Carrier

This field indicates the absolute RF channel number of the particular BTS.

Range: 0 - 1023

A.2. ~~1.~~2 RIT Measurement Response Message

The RIT Measurement Response is a message from the LMU to the SMLC. It is the response to the RIT Measurement Request. It contains the following information elements.

Table 2. RIT Measurement Response message content.

Information element	*Type/Reference*	*Presence*
Message Type	Message Type A.2.2.1.1	M
RIT Measurement	RIT Measurement A.2.2.1.2	M

A.2.2.1~~1.3~~ RIT Measurement Response Message Information Elements

A.2.2.1~~1.3~~.1 Message type IE

This IE contains the type of the message. This IE is mandatory.

A.2.2.1~~1.3~~.2 RIT Measurement IE

This IE includes the required RIT measurements. The length of this IE depends on the number of measured neighbor BTSs. This IE is mandatory.

Reference LAC

This field indicates the Location Area Code of the reference BTS. The purpose of the Location Area Code is to identify a location area.

Range: 0 - 65535

Reference CI

This field indicates the Cell Identity value of the reference BTS. The purpose of the Cell Identity value is to identify a cell within a location area.

Range: 0 - 65535

Reference Frame Number

This field indicates the frame number of the last measured burst from the reference BTS.

Range: 0 - 2715647

Response Type

This field indicates whether AT of reference BTS is reported or not.

‘0’: AT of reference BTS is not reported

‘1’:AT of reference BTS is reported

Common Clock

This field indicates the type of the common reference clock for AT measurement. This field is included only if the Response Type field is ‘1’.

‘0’: GPS clock is used.

‘1’: Reserved for future use (e.g. Synchronized atomic clocks, or GLONASS)

Reference AT

This field indicates the measured AT value for the serving BTS. It is the starting moment of a time slot. It is counted as elapsed time in units of 0.004 micro-seconds since last minute change. This field is included only if the Response Type field is ‘1’.

Range: 0 – 15,999,999,999

Reference AT Change

This field indicates the first time derivative of the AT value for the reference BTS. This value is based on measurements made during Monitor Period**.** This field is conditional and included if the Monitor Period field has been present in RIT measurement request message and Response Type field is ‘1’. The range is -0.05 … 0.05 ppm and resolution is 0,00005 ppm.

Range: -1000 … 1000

Reference Time Slot

Reference Time Slot indicates the time slot relative to which the LMU reports the reference BTS measurements. This field is mandatory.

Range: 0 to 7

Note: If the LMU does not know timeslot scheme, the LMU reports the used timeslot. The LMU can only report results based on one time slot (N) or two time slots (N and N+4). If the LMU knows timeslot scheme, the LMU can make measurements from several timeslots and reports that the used timeslot is zero (and makes correction).

Reference RX Level

RX Level field includes the received signal strength of the reference BTS.

The RX Level is expressed in 2 dBm steps within the range -150 .. –24 dBm.

Range: 0 .. 63

Quality Type

Quality type field defines the used quality type of Reference Quality field and Neighbor Quality field.

‘0’: Std of TOA measurements from the BTS. Values are expressed in tens of meters.

‘1’: Std of TOA measurements from the BTS. Values are expressed in hunderts of meters.

‘2’: SNR estimate. Range is –30 … +33 dB.

‘3’: Undefined relative quality value.

‘4’: Reserved.

Reference Quality

Serving Quality field includes the quality value of made measurements from the serving BTS. Range is defined by Quality Type field. This Reference Quality field can be e.g. used to evaluate the reliability of RIT measurements in the SMLC.

Range: 0 to 64

Number of Measured Neighbors

This field indicates the number of different neighbor BTSs.

Note: If the LMU can not measure any neighbor BTSs, then this value is set to ‘0’.

Range: 0 – 15~~31~~

The following fields are repeated the number of times included in Number of Measured Neighbors field.

CellIdType

This field indicates is the identity method of the cell.

‘0’ = Cell identity is told using BSIC and BCCH carrier.

‘1’ = Cell identity is told using CI.

Neighbor CI

This field indicates the Cell Identity of the particular neighbor cell. The purpose of the Cell Identity value is to identify a cell within a location area.

Neighbor CI field is a conditional field and it is included only if CellIdType is set ‘1’ and CI value of the given cell is available.

Range: 0 - 65535

Neighbor BSIC

This field indicates the BSIC (Base Station Identity Code of the base station).

BSIC field is conditional and it is included only if CellIdType is set ‘0’.

Range: 0 - 63

Neighbor BCCH Carrier

This field indicates the absolute RF channel number of the neighbor base station. BCCH carrier field is conditional and it is included only if CellIdType is set ‘0’.

Range: 0 - 1023

Neighbor RX Level

RX Level field includes the received signal strength on the neighbor BTS.

The RX Level is expressed in 2 dBm steps within the range -150 .. –24 dBm.

Range: 0 .. 63

Neighbor Frame Number

This field indicates the calculated value of the neighbor BTS's frame that would have been received at the same time or immediately after as the last measured frame from the reference BTS. This field is optional.

Range: 0 - 2715647

Neighbor Time Slot

Neighbor Time Slot indicates the time slot relative to which the LMU reports the serving BTS measurements. This field is mandatory.

Range: 0 to 7

Note: If the LMU does not know timeslot scheme, the LMU reports the used timeslot. The LMU can only report results based on one time slot (N) or two time slots (N and N+4). If the LMU knows timeslot scheme, the LMU can make measurements from several timeslots and reports that the used timeslot is zero (and makes correction).

Neighbor Quality

Neighbor Quality field includes the quality of made RIT measurements from neighbor BTS. The intepretation of the Neighbour Quality field is defined by Quality Type field. This Neighbor Quality field can be e.g. used to evaluate the reliability of RIT measurements in the SMLC. This field is mandatory.

Range: 0 to 64

ATD/RTD Value

This field indicates the measured ATD/RTD value between the receptions of signals from the reference and the neighbor BTS. This ATD/RTD value is the difference in reception of signal (the starting moment of time slot) from reference BTS compared to the signal (next starting moment of a time slot) from the neighbor BTS (i.e. this value is always positive). This field is mandatory. The reporting resolution of ATD/RTD value is 0.005 micro-seconds.

Range: 0 … 923200

Note: The reported ATD/RTD value may be based on some filtering or estimation algorithm. I.e. the reported value is not the last measurement result, it is the best estimate of real RTD value at the time of last measurement.

ATD/RTD Change

This field indicates the first time derivative of the ATD/RTD value between the receptions of signals from the reference and the neighbor BTS. This value is based on measurements made during Monitor Period**.** This field is conditional and included if the Monitor Period field has been present in RIT measurement request message. The range is -0.05 … 0.05 ppm and resolution is 0,00005 ppm.

Range: -1000 … 1000

A.2.~~2~~3 RIT Measurement Stop Message

The RIT Measurement Stop is a message from the SMLC to the LMU. It is sent when the SMLC wants the LMU to stop doing RIT measurements and reporting them. It contains the following information elements.

Table 5. RIT Measurement Stop message content.

Information element	*Type/Reference*	*Presence*
Message Type	Message Type A.2.3.1.1	M

A.2.~~2~~3.1 RIT Measurement Stop Message Information Elements

A.2.3.1.1.~~1.~~ Message type IE

This IE contains the type of the message. This IE is mandatory.

A.2.~~3~~4 RIT Measurement Error Message

The RIT Measurement Error is a message from the LMU to the SMLC. It is sent any time when the LMU can not perform RIT measurements asked for in the RIT Measurement Request. This message can be returned in return result (after reception of measurement command) or as separate message (during periodic measurement). It contains the following information elements.

Table 6. RIT Measurement Error message content.

Information element	*Type/Reference*	*Presence*
Message Type	Message Type A.2.4.1.1	M
Error Type	RIT Error Type A.2.4.1.2	M
RIT Error	RIT Error A.2.4.1.3	M

A.2.~~3~~4.1 RIT Measurement Error Message Information Elements

A.2.~~3~~4.1.1 Message type IE

This IE contains the type of the message. This IE is mandatory.

A.2.~~3~~4.1.2 RIT Error Type IE

This IE indicates whether the error is temporarily (e.g. GPS reset) or permanent errors. Permanent error requires actions in SMLC, temporarily error informs that LMU can not send results temporarily (but it is expected to recover without any actions from SMLC).

‘0’ = Permanent error

‘1’ = Temporarily error

A.2.~~3~~4.1.3 RIT Error IE

The purpose of the RIT Error IE is to provide the indication of error and the reason for it, when the LMU can not report required RIT results. This IE is mandatory. This IE has the following fields.

Error Reason

This field indicates the reason for error.

'0': There were no neighbor BTSs to be received.

'1': No ATD measurements were possible, since the common reference clock was not available.

'2': Requested type of measurements is not supported.

'3': Undefined error.

Annex B (informative): TOA messages

B.1 Messages

The following TOA related messages are exchanged between the SMLC and the LMU.

1. Perform TOA Measurement (MLC->LMU)
2. TOA Measurement Result (response to 1. LMU-> MLC)

B.1.1 Perform TOA Measurement Message

The Perform TOA Measurement is a message from the SMLC to the LMU. As a response to it the LMU measures Time Of Arrival of MS transmitted signals. The signal characteristics are specified in the message. It contains the following information elements.

Table 1. Perform TOA Measurement message content.

Information element	*Type/Reference*	*Presence*
Message Type	Message Type IE 3.1	M
Measurement Device Info	Measurement Device Info IE 3.2	M
Channel Description	Channel Description IE 3.3	M
Signal Description	Signal Description IE 3.4	M
Timing Description	Timing Description IE 3.5	M
Measurement Options	Measurement Options IE 3.6	O

B.1.2 TOA Measurement Result Message

The TOA Measurement Result is a message from the LMU to the MLC. It is a response to the Perform TOA Measurement message and contains the following information elements.

Table 2. TOA Measurement Result message content.

Information element	*Type/Reference*	*Presence*
Message Type	Message Type IE 3.1	M
Number of Measurement Devices	Number of Measurement Devices IE 3.7	M
Timing Info	Timing Info IE 3.8	M
The following is repeated "Number of Measurement Devices" times		
Measurement Device ID	Measurement Device	M

	ID IE 3.10	
Measurement Info	Measurement Info IE 3.11	M
Number of Peaks	Number of Peaks IE 3.12	M
The following is repeated "Number of Peaks" times		
Measured TOA	Measured TOA IE 3.13	M
TOA Quality	TOA Quality IE 3.14	M

B.2 Information element encodings

B.2.1 Message Type IE

This IE contains the type of the message.

Range: 0 – 255

B.2.2 Measurement Device Info IE

This IE indicates the LMU Measurement Devices that are addressed with the message. (One physical LMU may contain several devices, e.g. an LMU co-located with a three sector site would normally contain three devices). It contains the following fields:

Number of Measurement Devices

This field indicates the number of LMU Measurement Devices that are addressed with the message. This field is mandatory.

Range: 1-6~~8~~

The following field is repeated "Number of Measurement Devices" times

Measurement Device ID

This field indicates the ID of the LMU Measurement Device.

Range: 0 -5~~7~~

B.2.3 Channel Description IE

The purpose of the Channel Description IE is to inform the LMU about the physical channel used by MS. This IE contains the following fields:

Frequency List Type

This field describes the format of the frequency information. If both frequency list and index is provided then the LMU shall store the frequency list and its associated index. If only an index is provided the LMU shall use the associated frequency list.

'0': Frequency list only

'1': Frequency list and index

'2': Frequency list index only

Frequency list index

This field identifies a frequency list either provided with this message or stored by the LMU. This field is present when “Frequency List Type” is equal to 1 or 2.

Range: 0-31

Number of ARFCNs

This field indicates the number of frequencies used by MS. This field is present if “Frequency List Type” is equal to 0 or 1.

Range: 1-64

The following field is repeated the number of times indicated by the “Number of ARFCNs” field.

ARFCN

This field indicates the absolute radio frequency number. This field is present if “Frequency List Type” is equal to 0 or 1.

Range: 0-1023

Hopping

This field indicates if frequency hopping is used. This field is mandatory.

‘0’: No hopping

‘1’: Hopping

MAIO

This field indicates the Mobile Allocation Index Offset used in the frequency hopping algorithm (see GSM 05.02). This field is present if Hopping=’1’.

Range: 0-63

HSN

This field indicates the Hopping Sequence Number used in the frequency hopping algorithm (see GSM 05.02). This field is present if Hopping=’1’.

Range: 0-63

Frame Number

This field indicates the Frame Number modulo 84864 of the first burst expected from the MS. It is used in the frequency hopping algorithm (see GSM 05.02). This field is present if Hopping=’1’.

Range: 0-84863

Channel Type

This field indicates the channel type. This field is mandatory.

‘0’: TCH/F

‘2’: TCH/H SCN=0

‘3’: TCH/H SCN=1

Number of Bursts

This field indicates the number of bursts to measure TOA on. This field is mandatory. The field is coded as follows

Value	Number of Bursts
0	5

1	10
2	20
3	40
4	70
5	140
6	280
7	560

B.2.4 Signal Description IE

The purpose of the Signal Description IE is to inform the LMU about the signal transmitted by MS. It contains the following fields:

Burst Type

This field contains the burst type transmitted by MS.

‘0’: Access Burst

‘1’: Normal Burst

Handover Reference

This field contains the handover reference number which together with BSIC completely defines the data portion of the access burst. This field is present when Burst Type = ‘0’.

Range: 0 -255

BSIC

This field indicates the BSIC (Base Station Identity Code) which together with Handover Reference Number defines the data portion of an access burst. This field is present when Burst Type= ‘0’.

Range: 0 – 63

TSC

This field indicates the Training Sequence Code used by MS. This field is present when Burst Type=’1’.

Range: 0-7

B.2.5 Timing Description IE

This IE provides information about the predicted arrival time of MS signals. It contains the following fields:

Time Reference

This field indicates the used clock reference. This field is mandatory.

‘0’: GPS time

‘1’: GSM time

‘2’-‘3’: Reserved for future use

GPS Start Time

This field indicates the predicted signal arrival time expressed in GPS time. The signal arrival time (TOA) is defined as the start point of a time slot. It is counted in units of 4 micro-second modulo 60s. To remove any ambiguity, let RT denote the reception time, ST denote the start time, and T an arbitrary time. Then if

1) (ST-RT) mod 60s <= 40s

then the indicated start time is the next time when T mod 60s is equal to ST.

It is possible that a request arrives late so that 1) is not fulfilled but before all bursts have been transmitted. It is in such a case possible to perform measurements on the remaining bursts if condition

2) (RT-ST) mod 60s ≤ Δ.

is fulfilled. Here Δ denotes the length of the complete measurement interval. It can be derived from the fields Channel Type and the Number of Bursts.

Should however neither of 1) or 2) be fulfilled then the request arrived too late and the bursts were missed.

This field is present when Time Reference='0'

Range: 0 – 14,999,999

GPS SV

This IE identifies a GPS clock SV (Space Vehicle) used for time stamping. Value 0 means that all available GPS sources should be used for deriving a time stamp. This field is present if Time Reference = '0'.

Range: 0-31

BCCH

This field indicates the ARFCN (BCCH) of the BTS whose clock is used as reference for Start Time. This field is present when Time Reference='1'.

Range: 0 – 1023

BSIC

This field indicates the Base Station Identity Code of the BTS whose clock is used as reference for Start Time. This field is present when Time Reference='1'.

Range: 0 – 63

GSM Start Time

This field indicates the predicted signal arrival time expressed in GSM time. It is expressed as Frame Number FN modulo 42432, Time slot Number TN and Bit Number BN. The reference point for signal arrival time (TOA) is defined as the start point of a time slot. The start time can encode only an interval of time of 42 432 frames, that is to say around 195.8 seconds. To remove any ambiguity, let RFN denote the frame number at reception, and FN' denote an arbitrary frame number. Then if

1) (FN-RFN) mod 42432 ≤ 31623

then the indicated starting FN is the next time when FN' mod 42432 is equal to FN.

It is possible that a request arrives late so that 1) is not fulfilled but before all bursts have been transmitted. It is in such a case possible to perform measurements on the remaining bursts if the condition

2) (RFN-FN) mod 42432 ≤ Δ.

is fulfilled. Here Δ denotes the length of the complete measurement interval. It can be derived from the fields Channel Type and the Number of Bursts.

Should however neither of 1) or 2) be fulfilled then the request arrived too late and the bursts were missed.

This field is present when Time Reference='1'. It contains the following subfields:

FN (mod 42432):

Range: 0 – 42432

TN:

Range: 0 – 7

BN:

Range: 0 – 156

Start Time Uncertainty

This field indicates the uncertainty in the arrival of the signal from MS. Expressed in GSM bit periods (i.e. 48/13 micro-seconds). The burst is expected to arrive in the interval

[Start Time - Start Time Uncertainty, Start Time + Start Time Uncertainty]

This field is mandatory. The field is coded as follows.

Value	Uncertainty
0	2
1	3
2	4
3	5
4	7
5	10
6	13
7	17
8	20
9	25
10	35
11	45
12	55
13	65
14	90
15	140

B.2.6 Measurement Options IE

This IE indicates options for TOA measurement. It contains the following fields.

Method

This field defines the TOA algorithm to be used by LMU. A value of zero indicates that a default algorithm may be used. Remaining values are vendor specific. This field is mandatory.

Range: 0 – 7

Environment Characterization

This field indicates the expected multipath environment. This field is mandatory.

‘0’: possibly heavy multipath and NLOS conditions (e.g. bad urban or urban)

‘1’: no or light multipath and usually LOS conditions (e.g. suburban or rural)

‘2’: not defined or mixed environment

‘3’: reserved

‘4’: reserved (i.e. several values should be reserved)

Measurement Type

This field indicates whether LMU shall include an estimate of the Time of Arrival (TOA) and/or Angle of Arrival (AOA) with the measurement result.

‘0’: Report TOA only

‘1’: Report AOA only

‘2’: Report TOA and AOA

B.2.7 Number of Measurement Devices IE

This IE indicates the number of LMU Measurement Devices that are reporting with the message.

Range: 1-6~~8~~

B.2.8 Timing Info IE

This IE provides information about the used clock source for TOA measurement. It contains the following fields:

Time Reference

This field indicates the used clock reference. This field is mandatory.

‘0’: GPS time
‘1’: GSM time

‘2’-‘3’: Reserved for future use

BCCH

This field indicates the ARFCN (BCCH) of the BTS whose clock is used as clock reference. This field is present when Time Reference=’1’.

Range: 0 – 1023

BSIC

This field indicates the Base Station Identity Code of the BTS whose clock is used as clock reference. This field is present when Time Reference=’1’.

Range: 0 – 63

B.2.10 Measurement Device ID IE

This IE indicates the ID of the reporting LMU Measurement Device.

Range: 0 -5~~7~~

B.2.11 Measurement Info IE

This IE indicates additional information related to the signal measurement.

Method

This field indicates the used method for TOA measurement. This field is mandatory.

Range: 0 – 7

Diversity

This field indicates if diversity was used for measurements. This field is mandatory.

‘0’: Diversity was not used.

‘1’: Diversity was used.

Measured Number of Bursts

This field indicates the number of bursts used for TOA measurement. It is expressed as a ratio N = (number measured)/(number requested). This field is mandatory. It is coded as follows.

0	$0 \leq N < 1/7$
1	$1/7 \leq N < 2/7$
2	$2/7 \leq N < 3/7$
3	$3/7 \leq N < 4/7$
4	$4/7 \leq N < 5/7$
5	$5/7 \leq N < 6/7$
6	$6/7 \leq N < 1$
7	N=1

Angle of Arrival

This field indicates the Angle of Arrival in units of 0.1 degrees. This field is optional.

Range: 0 - 3599

AOA Uncertainty

This field indicates the quality of Angle of Arrival (AOA) estimate in units of 0.1 degrees. It is defined as follows. Let Θ denote the estimated AOA, Θ_0 denote the true AOA, and r denote the uncertainty. Then Prob($|\Theta-\Theta_0| < r$) = 67%, i.e. with 67% confidence the true AOA lies in the interval [Θ-r, Θ+r]. The uncertainty r, expressed in degrees, is mapped to a number K, with the following formula:

$$r = C\left((1+x)^K - 1\right)$$

with C = 0.446 and x = 0,25. With $0 \leq K \leq 30$, a useful range between 0.1 degrees and 360 degrees is achieved for the uncertainty. K is the value being sent. A value of 31 means that the measurement failed. This field is optional.
Range: 0 -31

B.2.12 Number of Peaks IE

This IE indicates the number of peaks (i.e. TOA values) reported.

Range: 0 - 4~~7~~

B.2.13 Measured TOA IE

This IE indicates the absolute TOA value (modulo the duration of a TDMA frame) determined by LMU. Expressed in units of 0.004 micro-seconds relative to the starting time.

Range: -131072 - +131071

B.2.14 TOA Quality IE

This IE indicates the TOA quality determined by LMU. It contains the following fields:

TOA Uncertainty

This field indicates the uncertainty of the TOA estimate. It is defined as follows. Let τ denote the estimated TOA, τ_0 denote the true TOA, and r denote the uncertainty. Then Prob($|\tau-\tau_0| < r$) = 67%, i.e. with 67% confidence the true TOA lies in the interval [τ-r, τ+r]. The uncertainty r, expressed in nanoseconds, is mapped to a number K, with the following formula:

$$r = C\left((1+x)^K - 1\right)$$

with C = 25 and x = 0.12. With $0 \le K \le 62$, a suitably useful range between 3 ns and 28 µs is achieved for the uncertainty. A value of 63 means that the measurement failed. This field is optional.

Range: 0 - 63

SNR Estimate

This field indicates the estimated Signal To Noise ratio. Values are expressed in steps of 1 dB ranging from –30 to + 33. This field is optional.

Range: 0 - 63

TOA Signal Strength

This field indicates the estimated Signal Strength. Values are expressed in steps of 2dBm from –150 to –24 dBm. This field is optional.

Range: 0 - 63

Annex C (informative): Status Messages

C.1 Introduction

This annex describes the contents of messages related to the status of an LMU.

C.2 Messages

The messages below are considered to be transported between the SMLC and the LMU.

C.2.1 Status RequesttatusStatus Query Message

The Status RequesttatusStatus Query is a message from the SMLC to the LMU. It contains the following information elements.

Table 1. Status RequesttatusStatus Query message content.

Information element	*Type/Reference*	*Presence*
Message Type	Message Type C.52.1.1.1	M

C.2.1.1 Status RequesttatusStatus Query Message Information Elements

C.2.1.1.1 Message Type IE

This IE contains the type of the message. This IE is mandatory.

C.2.2 Status Query Resultponse Message

The Status Query Resultponse is a message from the LMU to the SMLC. It contains the following information elements.

Table 2. Status Query Resultponse message content.

Information element	*Type/Reference*	*Presence*
Message Type	Message Type C.25.2.1.1	M
Time	Time C.25.2.1.2	M
RIT Status	RIT Status C.25.2.1.3	M
TOA Status	TOA Status C.25.2.1.4	M
O&M Status	O&M Status C.25.2.1.5	M

C.2.2.1 Status Query Resultponse Message Information Elements

C.2.2.1.1 Message Type IE

This IE contains the type of the message. This IE is mandatory.

C.2.2.1.2 Time IE

This IE contains the time stamp for this message. This IE is mandatory, and it contains the following fields:

Reference LAC

This field indicates the Location Area Code of the reference BTS. The purpose of the Location Area Code is to identify a location area.

Range: 0 - 65535

Reference CI

This field indicates the Cell Identity value of the reference BTS. The purpose of the Cell Identity value is to identify a cell within a location area.

Range: 0 - 65535

Reference Frame Number

This field indicates the frame number of the last measured burst from the reference BTS.

Range: 0 - 2715647

C.2.2.1.3 RIT Status IE

The purpose of the RIT Status IE is to inform the SMLC about the status of on-going RIT related activity. This IE is mandatory, and it contains the following fields:

RIT Jobs

This field indicates the number of on-going RIT related jobs, i.e. the number of neighbor BTSs that are tried to be measured. Notice that 0 means that no RIT related activity is on-going.

Range: 0 – 63

C.2.2.1.4 TOA Status IE

The purpose of the TOA Status IE is to inform the SMLC about the status of on-going TOA related activity. This IE is mandatory, and it contains the following fields:

TOA Jobs

This field indicates the number of on-going TOA related jobs, i.e. the number of MSs that are tried to be measured. Notice that 0 means that no TOA related activity is on-going.

Range: 0 – 63

C.2.2.1.5 O&M Status IE

The purpose of the O&M Status IE is to inform the SMLC about the status of on-going O&M related activity. This IE is mandatory, and it contains the following fields:

O&M Jobs

This field indicates the number of on-going O&M related jobs.

Range: 0 – 63

C.2.3. Status ~~Report~~ Update Message

The Status ~~Report~~Update is a message from the LMU to the SMLC. It contains the following information elements.

Table 2. Status Response message content.

Information element	*Type/Reference*	*Presence*
Message Type	Message Type C.2.3.1.1	M
Reason for Status Update	Reason for Status Update C.2.3.1.2	M
Time	Time C.2.2.1.2	M
RIT Status	RIT Status C.2.2.1.3	M
TOA Status	TOA Status C.2.2.1.4	M
O&M Status	O&M Status C.2.2.1.5	M

C.2.3.1. Status Update Message Information Elements

C.2.3.1.1. Message Type IE

This IE contains the type of the message. This IE is mandatory.

C.2.3.1.2. Reason for Status Update IE

This IE contains the reason for sending this Status Update Message. This IE is mandatory, and it contains the following fields:

Reason Code

This field indicates Reason code for sending this Status Update Message.

‘0’: power up (no knowledge about previous states)

‘1’: SW reset, unsuccessful recovery

‘2’: SW reset, successful recovery

‘3’: unknown selfdiagnosis error

'4': unreliable timebase error

‘5’: periodic status report, normal operation

Annex D (informative): Status of Technical Specification GSM 04.71

Status of Technical Specification GSM 04.~~XX~~71		
Date	**Version**	**Remarks**
11.12.98	0.0.1	First Draft by Nokia to Clearwater T1P1 meeting
8.1.99	0.0.2	Second Draft by Nokia to Austin T1P1 meeting
29.1.99	0.0.3	Third Draft by Nokia to Chicago T1P1 meeting
5.2.99	1.0.0	Accepted version based on in Chicago T1P1 meeting
18.3.99	1.0.1	Updated according to agreement in Dallas T1P1 meeting
12.5.99	1.0.2	Updated according to agreement in Savannah T1P1 meeting
9.6.99	1.1.0	Updated according to agreement in Cambridge T1P1 meeting
10.6.99	2.0.0	Update to version 2.0.0
Text and figures: **ASN.1:** **Stylesheet**: **Rapporteur**:		

History

Document history		
V7.0.0	August 1999	Publication

3GPP TSG-CN-WG1, Meeting #8
25-29 October 1999
Kobe, Japan

Tdoc N1-99C15

CHANGE REQUEST

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

09.08	**CR**	**A??**	Current Version: 7.0.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑ *↑ CR number as allocated by MCC support team*

For submission to:	TSGN1	for approval	X	strategic		*(for SMG*
list expected approval meeting # here ↑		for information		non-strategic		*use only)*

Form: CR cover sheet, version 2 for 3GPP and SMG The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

Proposed change affects: *(at least one should be marked with an X)*	(U)SIM		ME		UTRAN / Radio		Core Network	X

Source: T1P1.5 **Date:** 25.10.99

Subject: Addition of further LCS functionality in GSM Release 98

Work item: Location Services (LCS)

Category:				**Release:**		
	F	Correction			Phase 2	
	A	Corresponds to a correction in an earlier release			Release 96	
(only one category	B	Addition of feature			Release 97	
Shall be marked	C	Functional modification of feature	X		Release 98	X
With an X)	D	Editorial modification			Release 99	
					Release 00	

Reason for change: Replacing LOCATION INFORMATION COMMAND and LOCATION INFORMATION REPORT messages with CONNECTION ORIENTED INFORMATION message. Location request related messages PERFORM LOCATION REQUEST, PERFORM LOCATION RESPONSE and PERFORM LOCATION ABORT needs to be added in BSSMAP messages transferred on the E-interface.

Clauses affected: 6

Other specs affected:				
	Other 3G core specifications		→ List of CRs:	
	Other GSM core specifications	X	→ List of CRs:	LCS CR to 08.08
	MS test specifications		→ List of CRs:	
	BSS test specifications		→ List of CRs:	
	O&M specifications		→ List of CRs:	

Other comments:

help.doc

<--------- double-click here for help and instructions on how to create a CR.

6 BSSMAP messages transferred on the E-interface

The following BSSMAP messages, defined in GSM 08.08 subclause 3.2.1, are transferred on the E-interface:

ASSIGNMENT REQUEST (MSC-A -> MSC-I)

Excluded information element: CIRCUIT IDENTITY CODE

ASSIGNMENT COMPLETE (MSC-I -> MSC-A)

Excluded information element: CIRCUIT POOL, CIRCUIT IDENTITY CODE

ASSIGNMENT FAILURE (MSC-I -> MSC-A)

Excluded information elements: CIRCUIT POOL, CIRCUIT POOL LIST

* HANDOVER REQUEST (MSC-A -> MSC-T and MSC-I -> MSC-A)

Excluded information element: CIRCUIT IDENTITY CODE

* HANDOVER REQUEST ACKNOWLEDGE (MSC-T -> MSC-A and MSC-A -> MSC-I)

Excluded information element: CIRCUIT POOL, CIRCUIT IDENTITY CODE

* HANDOVER COMPLETE (MSC-T -> MSC-A)

* HANDOVER FAILURE (MSC-T -> MSC-A and MSC-I -> MSC-A)

Excluded information elements: CIRCUIT POOL, CIRCUIT POOL LIST

HANDOVER PERFORMED (MSC-I -> MSC-A)

* HANDOVER DETECT (MSC-T -> MSC-A)

CLEAR REQUEST (MSC-I -> MSC-A)

SAPI "n" REJECT (MSC-I -> MSC-A)

CONFUSION (MSC-T -> MSC-A, MSC-A -> MSC-T, MSC-I -> MSC-A and MSC-A -> MSC-I)

MSC INVOKE TRACE (MSC-A -> MSC-I)

BSS INVOKE TRACE (MSC-I -> MSC-A and MSC-A -> MSC-T)

CIPHER MODE COMMAND (MSC-A -> MSC-I)

CIPHER MODE COMPLETE (MSC-I -> MSC-A)

CIPHER MODE REJECT (MSC-I -> MSC-A)

** QUEUING INDICATION (MSC-T -> MSC-A, MSC-I -> MSC-A, and MSC-A -> MSC-I)

CLASSMARK UPDATE (MSC-I -> MSC-A and MSC-A -> MSC-T)

CLASSMARK REQUEST (MSC-A -> MSC-I)

~~LOCATION INFORMATION COMMAND (MSC-A -> MSC-I)~~

CONNECTION ORIENTED INFORMATION~~LOCATION INFORMATION REPORT~~ (MSC-I -> MSC-A, MSC-A->MSC-I)

PERFORM LOCATION REQUEST (MSC-I->MSC-A, MSC-A -> MSC-I)

PERFORM LOCATION ABORT (MSC-I->MSC-A, MSC-A -> MSC-I)

PERFORM LOCATION RESPONSE (MSC-I -> MSC-A, MSC-A->MSC-I)

All other BSSMAP messages shall be considered as non-existent on the E-interface.

Some of the messages above are qualified by *, ** or #. This signifies whether the message, when sent on the E-interface, is considered as:

- handover related message (*);
- handover related when sent as a response to HANDOVER REQUEST (**); or
- trace related message (#).

3GPP TSG-CN-WG1, Meeting #8
25-29 October 1999
Kobe, Japan

Tdoc N1-99C16

T1P1.5/99-469r3

GSM 09.31 V1.0.0 (1999-11)

Technical Specification

Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Base Station System Application Part LCS Extension (BSSAP-LE) (GSM 09.31 version 1.0.0 Release 1998)

Reference

xxxxxxxxxxxxxxxxxxxxxx

Keywords

Digital cellular telecommunications system,
Global System for Mobile communications (GSM)

ETSI

Postal address

F-06921 Sophia Antipolis Cedex - FRANCE

Office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Internet

secretariat@etsi.fr
http://www.etsi.fr
http://www.etsi.org

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available **free of charge** from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://www.etsi.fr/ipr or http://www.etsi.org/ipr).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This ETSI Technical Specification (TS) has been produced by the T1P1 Wireless/Mobile Services and Systems Technical Subcommittee.

This TS defines the coding of information in an extension of the Base Station System Application Part (BSSAP) that is needed to support location services on interfaces based on use of BSSAP.

The contents of this specification are subject to continuing work within SMG and T1P1 and may change following formal SMG and T1P1 approval. Should SMG or T1P1 modify the contents of this specification it will then be re-issued with an identifying change of release date and an increase in version number as follows:

Version 7.x.y

where:

7 GSM Phase 2+ Release 1998;

x the second digit is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.;

y the third digit is incremented when editorial only changes have been incorporated in the specification.

1 Scope

This GSM Technical Specification specifies procedures and information coding that are needed to define and support the BSSAP LCS Extension (BSSAP-LE). The BSSAP-LE message set is applicable to the following GSM interfaces defined in GSM 03.71:

Lb interface (BSC-SMLC)

Ls interface (MSC-SMLC)

Lp interface (SMLC-SMLC)

This specification defines message formats and encoding for BSSAP-LE and the particular subsets of it that are applicable to each of the above interfaces. This specification also defines the support for BSSAP-LE message transfer on each of these interfaces using CCITT and ANSI versions of SS7 MTP and SCCP. Additional requirements for the above interfaces that are applicable to BSSAP-LE are also defined – e.g. usage of BSSAP (as defined in GSM 04.08 and 08.08) on the Lb interface.

2. References

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 03.71: “Digital cellular telecommunications system (Phase 2+); Location Services (LCS); (Functional description) - Stage 2”

[3] GSM 04.08: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification".

[4] GSM 04.31: “Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Mobile Station (MS) – Serving Mobile Location Center (SMLC); Radio Resource LCS Protocol (RRLP).”

[5] GSM 04.71: “Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 Location Services (LCS) specification”.

[6] GSM 08.06: ” Digital cellular telecommunications system (Phase 2+); Signaling transport specification mechanism for the Base Station Subsystem – Mobile-services Switching Centre (BSS - MSC) interface”.

[7] GSM 08.08: ” Digital cellular telecommunications system (Phase 2+); Mobile-services Switching Centre – Base Station System (MSC-BSS) interface; Layer 3 specification”

[8] GSM 08.31: “Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Serving Mobile Location Center (SMLC) – Serving Mobile Location Center (SMLC); SMLC Peer Protocol (SMLCPP).”

[9] GSM 08.71: “Digital cellular telecommunications system (Phase 2+); Location Services (LCS); Serving Mobile Location Center – Base Station Subsystem (SMLC-BSS) interface Layer 3 specification.”

[10] GSM 09.02: "Digital cellular telecommunications system (Phase 2+); Mobile Application Part (MAP) specification".

[11] CCITT Recommendation Q.702: "Specifications of Signalling System No. 7 - Signalling data link".

[12] CCITT Recommendation Q.703: "Signalling link".

[13] CCITT Recommendation Q.704: "Signalling network functions and messages".

[14] CCITT Recommendation Q.707: "Specifications of Signalling System No. 7 - Testing and maintenance".

[15] CCITT Recommendation Q.711: "Functional description of the signalling connection control part".

[16] CCITT Recommendation Q.712: "Definition and function of SCCP messages".

[17] CCITT Recommendation Q.713: "SCCP formats and codes".

[18] CCITT Recommendation Q.714: "Signalling connection control part procedures".

[19] ANSI T1.111-1996 - Signalling System Number 7 (SS7) – Message Transfer Part (MTP)

[20] ANSI T1.112-1996 - Signalling System Number 7 (SS7) - Signalling Connection Control Part (SCCP).

3. Definitions, symbols and abbreviations

Unless listed below, all definitions, symbols and abbreviations used in this specification are listed in GSM 01.04 and GSM 03.71.

4. Definition of BSSAP-LE

BSSAP-LE is an extension to BSSAP that contains messages and parameters specific to the support of LCS. The following subsets of BSSAP-LE are defined: DTAP-LE, BSSMAP-LE.

4.1 DTAP-LE Messages

DTAP-LE messages are transfered between an SMLC and a Type A LMU and comprise the following individual messages:

REGISTER

FACILITY

RELEASE COMPLETE

The content, encoding and certain procedures asssociated with DTAP-LE messages are defined in GSM 04.71.

4.2 BSSMAP-LE Messages

BSSMAP-LE messages are transferred between a BSC, MSC and SMLC and comprise the following individual messages:

<u>BSSMAP-LE Positioning Messages</u>

Perform Location Request

Perform Location Response

Perform Location Abort

<u>BSSMAP-LE LMU Control Messages</u>

LMU Connection Request

LMU Connection Accept

LMU Connection Reject

LMU Connection Release

<u>BSSMAP-LE Information Messages</u>

Connection Oriented Information

Connectionless Information

The content and encoding of BSSMAP-LE messages are defined in this specification.

5. Procedures applicable to use of BSSAP-LE

5.1 Location Request

The Location Request procedure is applicable to the Lb and Ls interfaces. Its purpose is to obtain a location estimate and possibly velocity estimate for a target MS that is already in dedicated mode. It is also used to provide an MS with LCS assistance data or with a deciphering key for LCS broadcast assistance data. The initiator of a location request may be either the serving BSC or the visited MSC for the MS. The procedure makes use of SCCP connection oriented signaling on the Lb and Ls interfaces.

5.1.1 Successful Operation

The initiator of the location request (VMSC or serving BSC) sends a BSSMAP-LE Perform Location Request to the SMLC associated with the current serving cell for the target MS. The message contains the following mandatory (M), conditional (C) and optional (O) information, where conditional parameters are required if available.

Location Type (M)

Cell Identifier (M)

Classmark Information Type 2 (M)

LCS Client Type (O)

Chosen Channel (C)

LCS Priority (C)

Preferred LCS QoS (C)

Worst Case LCS QoS (C)

Requested GPS Data (C)

BSSLAP APDU (C)

If requested, the SMLC performs positioning of the target MS using a particular position method or a combination of more than one positioning method. Alternatively, if requested otherwise, the SMLC may provide positioning assistance data to the MS. The SMLC may invoke the following other BSSAP-LE procedures to perform these procedures:

connection oriented information transfer

connectionless information transfer

LMU connection establishment

LMU connection release

DTAP-LE information transfer

For an SMLC accessed over the Lb interface by a BSC initiator, additional procedures defined in GSM 04.08 and GSM 08.08 may also be performed. If a location estimate and possibly velocity estimate were requested and were subsequently obtained satisfying the required LCS QoS, the SMLC shall return a BSSMAP-LE Perform Location Response to the initiator of the location request (serving BSC or VMSC). This message contains the following mandatory, conditional and optional parameters.

Location Estimate (C)

Velocity Estimate (C)

Positioning Data (C)

Inclusion of at least one of a Location Estimate or Velocity Estimate is mandatory.

If assistance data was instead requested for an MS and the SMLC was able successfully to transfer this to the MS, the SMLC shall return a BSSMAP-LE Perform Location Response to the initiator of the location request (serving BSC or VMSC). This message shall contain no parameters. The absence of an LCS Cause parameter in this case implies that the transfer was successful.

Otherwise, if a deciphering key was requested for LCS broadcast assistance data and the SMLC has access to the appropriate key(s), the SMLC shall return a BSSMAP-LE Perform Location Response to the initiator of the location request (serving BSC or VMSC). This message contains the following mandatory, conditional and optional parameters.

~~Current~~ Deciphering Key (M)

~~Next Deciphering Key (C)~~

~~The next deciphering key shall be included if the applicability of the current deciphering key is less than a PLMN determined period.~~

5.1.2 Unsuccessful Operation

If the SMLC is unable to obtain any of the location and velocity information requested or none of the information obtained satisfies the requested LCS QoS or if requested LCS assistance data could not be transferred or requested deciphering keys for broadcast assistance data could not be returned, the SMLC shall return a BSSMAP-LE Perform Location Response to the initiator of the Location Request carrying the following parameters:

LCS Cause (M)

Positioning Data (O)

5.1.3 Abnormal Conditions

If an ongoing location request is preempted at the initiator by an inter-BSC handover or if the main signaling link to the target MS is lost or released or if there is a timeout waiting for the positioning response, the initiator shall send a BSSMAP-LE Perform Location Abort to the SMLC containing the following parameters.

LCS Cause (M)

On receipt of this message, the SMLC shall stop positioning of the target MS and may release any resources (e.g. LMUs) previously allocated. If ~~T~~the SMLC has not yet~~may~~ returned a BSSMAP-LE Perform Location Response to the initiator, it shall return this message containing an LCS Cause indicating an abort and, optionally, positioning data. ~~While this response is not required, its receipt by the initiator shall not be regarded as an error. The SMLC shall then release the SCCP connection to the initiator; t~~The initiator shall then~~may also~~ release the SCCP connection. If the SMLC cannot proceed with positioning due to some protocol violation or error condition (e.g. inter-BSC handover indication received from the serving BSC), it shall return a BSSMAP-LE Perform Location Response to the initiator containing an LCS cause and, optionally, positioning data. The initiator need not reply at the BSSAP-LE level to this message. However, the initiator may return a BSSMAP-LE perform Location Abort which shall not be treated as an error by the SMLC.

5.2 Connection Oriented Information Transfer

The Connection Oriented Information transfer procedure is applicable to the Lb and Ls interfaces. It enables both way transfer of BSSLAP messages between an SMLC and the BSC serving a target MS. The initiator of the procedure can be either the BSC serving the target MS, the visited MSC for the target MS or the SMLC. The procedure is only valid while a location request procedure for the target MS is ongoing. The procedure makes use of SCCP connection oriented signaling on the Lb and Ls interfaces and uses the same SCCP connection as the location request procedure for the particular target MS.

5.2.1 Successful Operation

An SMLC, MSC or BSC with a BSSLAP message or message segment to transfer concerning a particular target MS sends a BSSMAP-LE Connection Oriented Information message to a recipient carrying the following parameters:

BSSLAP APDU (M)

If the sender is an NSS based SMLC, the message is transferred to the VMSC for the target MS. The recipient MSC shall then transfer the message to the serving BSC using procedures defined in GSM 08.08.

If the sender is a BSS based SMLC, the message is transferred to the serving BSC for the target MS. The BSC shall then perform the positioning operation requested by the BSSLAP APDU (refer to GSM 08.71). If the BSSLAP APDU contains an RRLP APDU, the BSC shall transfer this to the target MS.

If the sender is a BSC or MSC and the intended recipient is the SMLC for a target MS, the message is transferred to the SMLC. The SMLC shall then perform interpretation of the BSSLAP APDU.

5.2.2 Abnormal Conditions

At an intermediate entity, if a received BSSMAP-LE Connection Oriented Information message contains unrecognized information or if the message cannot be sent on, the message shall be discarded.

At the receipient entity. if a received BSSMAP-LE Connectioin Oriented Information message contains invalid or unrecognized information as defined for BSSAP-LE, any ongoing positioning procedure shall be terminated and associated resources may be released. If the receipient is a BSC, the SMLC shall be notified – e.g. using a BSSLAP Reject or Abort. If the receipient is an SMLC, a new positioning attempt (e.g. using a different position method) may be started.

5.3 Connectionless Information Transfer

The Connectionless Information transfer procedure is applicable to the Lb, Ls and Lp interfaces. It enables both way transfer of LLP messages between an SMLC and a Type B LMU. The procedure also enables both way transfer of SMLCPP messages between two SMLCs. The initiator of the procedure can be a BSC, MSC or SMLC. The procedure makes use of SCCP connectionless signaling.

5.3.1 Successful Operation

An SMLC, MSC or BSC needing to transfer an LLP message concerning a Type B LMU or an SMLCPP message sends a BSSMAP-LE Connectionless Information message to a recipient carrying the following parameters:

Source Entity (M)

Destination Entity (M)

Return Error Request (O)

APDU (M)

The source entity identifies the sender. The recipient entity identifies the final destination. The Return Error Request may be included to request notification in the event of unsuccessful transfer. If the recipient entity is not the final destination, the recipient shall transfer the BSSMAP-LE Connectionless Information message to either the final destination or an intermediate MSC or BSC capable of onward transfer to the final destination.

5.3.2 Unsuccessful Operation

If the message cannot be transferred by an intermediate entity and the Return Error Request is not included, the message shall be discarded. If the Return Error Request is included, the intermediate entity shall send a BSSMAP-LE Connectionless Information message to, or towards, the original source containing the following parameters:

Source Entity (M)

Destination Entity (M)

Return Error Cause (M)

APDU (C)

The Source entity shall indicate the Destination Entity in the original received message. The Destination Entity shall indicate the Source Entity in the original message. The Return Error cause shall indicate the reason for unsuccessful transfer. The APDU shall contain any originally received APDU.

If a received BSSMAP-LE Connectionless Information message containing a Return Error Cause cannot be transferred by an intermediate entity, it shall be discarded with no return error message.

5.3.3 Abnormal Conditions

At an intermediate entity, if a received BSSMAP-LE Connectionless Information message contains unrecognized or invalid information, the message shall be discarded.

At the recipient entity. if a received BSSMAP-LE Connectioinless Information message contains invalid or unrecognized information as defined for BSSAP-LE, the message shall be discarded.

5.4 LMU Connection Establishment

The LMU Connection Establishment procedure is applicable to the Ls interface. Its purpose is to establish a signaling connection between an SMLC and Type A LMU via the visted MSC for the LMU. The procedure can be initiated by either the SMLC or MSC. The procedure makes use of SCCP connection oriented signaling on the Ls interface.

5.4.1 LMU Connection Establishment initiated by the SMLC

5.4.1.1 Successful Operation

The SMLC sends a BSSMAP-LE LMU Connection Request message to the VMSC for the LMU. This message contains the following parameters.

IMSI (M)

Sender Address (O)

Security (C)

The IMSI identifies the LMU. The sender address, if included, identifies the SMLC. The Security parameter shall be included if authentication or ciphering of the LMU are required. On receipt of this message, the MSC shall attempt to establish a signalling link to the LMU (refer to GSM 03.71). Authentication and ciphering shall be invoked if requested by the SMLC. Once the signaling link has been established, the MSC shall return a BSSMAP-LE LMU Connection Accept to the SMLC with the following parameters.

Call Number (O)

The call number shall be included if the MSC has the capability to support signaling to an LMU using a traffic channel (refer to GSM 03.71).

5.4.1.2 Unsuccessful Operation

If the LMU is not recognized in the MSC (e.g. no VLR record) or a signaling link cannot be setup to the LMU (e.g. paging of the LMU fails) or authentication or ciphering cannot be performed when requested by the SMLC, any signaling link to the LMU shall be released, if not required for other MM or CM procedures and a BSSMAP-LE LMU Connection Reject shall be returned to the SMLC with the following parameters.

Reject Cause (M)

5.4.1.3 Abnormal Conditions

If the SMLC or MSC detects release of the SCCP connection on the Ls interface for an LMU, the connection establishment procedure shall be considered to have failed and any associated resources may be released.

5.4.2 LMU Connection Establishment initiated by the MSC

5.4.2.1 Successful Operation

The MSC shall initiate the LMU connection establishment procedure when no LMU connection to the SMLC currently exists and the MSC receives a CM Service Request from the LMU specifying the LCS service. The MSC shall then send a BSSMAP-LE LMU Connection Request message to the SMLC associated with either the IMSI or current cell location of the LMU. This message shall contain the following parameters.

IMSI (M)

Sender Address (M)

Call Number (C)

The IMSI identifies the LMU. The sender address identifies the MSC. The call number shall be included if the MSC has the capability to support signaling to an LMU using a traffic channel (refer to GSM 03.71). On receipt of this message, the SMLC shall return a BSSMAP-LE LMU Connection Accept to the MSC with the following parameters.

Security (C)

The Security parameter shall be included if authentication or ciphering of the LMU are required On receipt of this message, the MSC shall perform authentication and/or ciphering if requested by the SMLC and shall complete the establishment of an MM connection to the LMU to support LCS.

5.4.1.2 Unsuccessful Operation

If the LMU is not recognized in the SMLC or a signaling connection cannot be supported (e.g. due to congestion), a BSSMAP-LE LMU Connection Reject shall be returned to the MSC with the following parameters.

Reject Cause (M)

The MSC shall then reject the CM service request from the LMU.

5.4.1.4 Abnormal Conditions

If the SMLC or MSC detects release of the SCCP connection on the Ls interface for an LMU, the connection establishment procedure shall be considered to have failed and any associated resources may be released.

5.5 LMU Connection Release

The LMU Connection Release procedure is applicable to the Ls interface. Its purpose is to release a signaling connection between an SMLC and Type A LMU. The procedure can be initiated by either the SMLC or MSC. The procedure makes use of SCCP connection oriented signaling on the Ls interface.

5.5.1 LMU Connection Release initiated by the SMLC

5.5.1.1 Successful Operation

The SMLC sends a BSSMAP-LE LMU Connection Release message to the VMSC for the LMU. This message contains the following parameters.

Release Cause (M)

On receipt of this message, the MSC shall release the main signaling link to the LMU unless required for other ongoing MM and CM procedures in the MSC. The MSC shall also initiate release of the SCCP connection to the SMLC for the LMU.

5.5.1.2 Abnormal Conditions

The SMLC may initiate release of the signaling connection to an LMU by initiating release of the SCCP connection for the LMU to the MSC. The MSC shall then release the main signaling link to the LMU unless required for other ongoing MM or CM procedures.

5.5.2 LMU Connection Release initiated by the MSC

5.5.1.1 Successful Operation

The MSC shall initiate release of an LMU connection to an SMLC if the main signaling link to the LMU is released. The MSC sends a BSSMAP-LE LMU Connection Release message to the SMLC for the LMU. This message contains the following parameters.

Release Cause (M)

On receipt of this message, the SMLC should initiate release of the SCCP connection to the MSC for the LMU.

5.5.1.3 Abnormal Conditions

The MSC may initiate release of the signaling connection between an SMLC and LMU by initiating release of the SCCP connection for the LMU to the SMLC.

5.6 DTAP-LE Information Transfer

The DTAP-LE Information transfer procedure is applicable to the Ls interface. It supports bothway LLP message transfer between an NSS based SMLC and Type A LMU. The procedure is only valid when a signaling connection between an SMLC and Type A LMU has been established. The procedure uses SCCP connection oriented signaling using the SCCP connection previously established between the SMLC and MSC when the signaling connection between the SMLC and LMU was established.

5.6.1 DTAP-LE Information Transfer Initiated by the SMLC

The SMLC initiates the procedure when it has an LLP message to transfer to a type A LMU. The message may first be segmented. The SMLC shall then transfer each LLP segment to the MSC inside a DTAP-LE REGISTER, FACILITY or RELEASE COMPLETE message. The usage of these messages is as defined in GSM 04.71. The MSC relays each DTAP-LE message to the LMU.

5.6.2 DTAP-LE Information Transfer Initiated by the MSC

The MSC initiates the procedure when a DTAP message is received from an LMU containing the LCS protocol discriminator. The MSC then relays the DTAP message to the SMLC

6. Usage of BSSAP-LE and BSSAP on the Lb Interface

6.1 Applicable Message Sets

The following BSSAP-LE message sets are applicable to the Lb interface between an SMLC and BSC:

All DTAP-LE messages

All BSSMAP-LE positioning messages

All BSSMAP-LE information messages

The following BSSMAP messages defined in GSM 08.08 are applicable to the Lb interface to support signaling to a Type A LMU using an SDCCH:

Cipher Mode Command (SMLC to BSC)

Cipher Mode Complete (BSC to SMLC)

Cipher Mode Reject (BSC to SMLC)

Clear Command (BSC to SMLC)

Clear Complete (BSC to SMLC)

Clear Request (SMLC to BSC)

Complete Layer 3 Information (BSC to SMLC)

Paging (SMLC to BSC)

The following additional BSSMAP messages defined in GSM 08.08 are applicable to the Lb interface to support signaling to a Type A LMU using a TCH:

Assignment Request (SMLC to BSC)

Assignment Complete (BSC to SMLC)

Assignment Failure (BSC to SMLC)

Block (bothway)

Blocking Acknowledge (bothway)

Reset (bothway)

Reset Ack. (bothway)

Unblock (bothway)

Unblocking Ack. (bothway)

Unequipped circuit (bothway)

The following DTAP messages defined in GSM 04.08 are applicable to the Lb interface to support signaling to a Type A LMU using an SDCCH:

RR Paging Response

All MM Messages

The following additional CM level DTAP messages defined in GSM 04.08 are applicable to the Lb interface to support signaling to a Type A LMU using a TCH.

Call Confirmed (LMU to SMLC)

Connect (LMU to SMLC)

Connect Acknowledge (SMLC to LMU)

Setup (SMLC to LMU)

Disconnect (bothway)

Release (bothway)

Release Complete (bothway)

6.2 MTP Functions

Except where defined otherwise in this specification, MTP requirements on the Lb interface for the BSC are the same as those defined for the A interface in GSM 08.06 for the BSC. MTP requirements on the Lb interface for the SMLC are the same as those defined for the A interface in GSM 08.06 for the MSC. STP functions are not required in the SMLC and a single signaling link set may be used between the BSC and SMLC. The BSC shall be homed to a single SMLC and shall only use the Lb signaling interface for signaling communication with the SMLC.

6.3 SCCP Functions

6.3.1 General

Except where defined otherwise in this specification, SCCP requirements on the Lb interface for the BSC are the same as those defined for the A interface in GSM 08.06 for the BSC. SCCP requirements on the Lb interface for the SMLC are the same as those defined for the A interface in GSM 08.06 for the MSC. Requirements concerning support of a type A LMU are the same as those in GSM 08.06 regarding support of a normal MS. In particular, usage of SCCP to transfer DTAP-LE messages between a type A LMU and SMLC are the same as those regarding transfer of other DTAP messages.

6.3.2 Modifications for Connectionless SCCP

Connectionless SCCP messages and procedures are used to transfer BSSMAP-LE Connectionless Information messages and those BSSMAP messages applicable to the Lb interface for which connectionless SCCP transfer is defined in GSM 08.08. Refer to GSM 03.71 for a description of the procedures in the SMLC and BSC. SCCP protocol class 1 shall be used when multiple BSSMAP-LE messages are transferred containing segments of a single fragmented LLP or SMLCPP message.

6.3.3 Modifications for Connection Oriented SCCP

Use of connection oriented SCCP messages and procedures on the Lb interfaces to support signaling access to a type A LMU using DTAP-LE, DTAP and BSSMAP messages is the same as that defined in GSM 08.06 on the A interface to support access to a normal MS.

To support positioning of a target MS, connection oriented SCCP messages and procedures using protocol class 2 shall be used to transfer BSSMAP-LE positioning messages and BSSMAP-LE Connection Oriented Information messages over the Lb interface. A separate dedicated SCCP connection shall be used to support positioning for each target MS. Connection establishment shall be instigated by the BSC when the positioning attempt commences. Connection release shall be instigated by either the BSC or SMLC when the positioning attempt has been completed or has failed.

Transfer of BSSMAP-LE messages using an SCCP connection to support positioning of a particular target MS is shown in the following figure. In particular, a BSSMAP-LE message shall be included in the data field of the SCCP CR and a BSSMAP-LE message may be included in the data field of an SCCP CC, CREF or RLSD message.

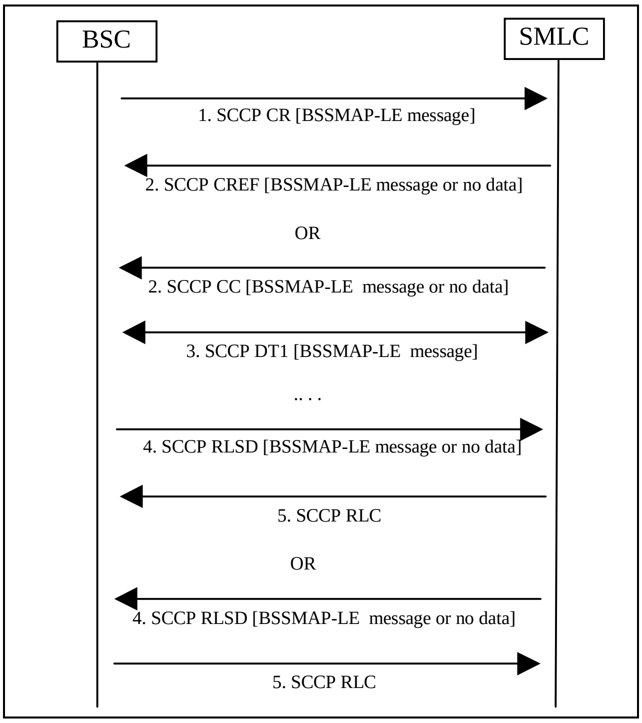


Figure 6.3.3/09.31 – SCCP Connection Oriented Signaling on Lb Interface for Positioning

6.3.4 Contents of the SCCP Data Field

The contents of the SCCP data field are the same as that defined for the A interface in GSM 08.06 for MSC-BSC signaling. In particular, the same conventions are used to transfer and discriminate between any BSSAP and DTAP message contained within the SCCP data field. Since all BSSAP-LE messages applicable to the Lb interface use the same encoding as for the A interface, the conventions used to discriminate a BSSMAP message are applicable to any BSSMAP-LE message on the Lb interface, while the conventions for a DTAP message apply to any DTAP-LE message.

7. Use of BSSAP-LE on the Ls Interface

7.1 Applicable Message Sets

The following BSSAP-LE messages are applicable to the Ls interface between an MSC and SMLC:

All DTAP-LE messages

All BSSMAP-LE positioning messages

All BSSMAP-LE LMU control messages

All BSSMAP-LE information messages

7.2 MTP Functions

SS7 signaling on the Ls interface may be supported using 56 kbps or 64 kbps digital signaling channels. These may be supported within either E1 or T1 physical links.

For E1 links or where CCITT/ITU SS7 signaling is applicable, the MTP functions as specified in CCITT Recommendations Q.702, Q.703, Q.704 and Q.707 are applicable. For T1 links or where ANSI SS7 signaling is applicable, the MTP functions as specified in ANSI T1.111 are applicable. For the SMLC, the requirements in these recommendations for a signaling end point are applicable. For the MSC, the requirements in these recommendations for both a signaling end point and signaling transfer point (STP) are applicable. MSC support of STP functions is only required for situations in which the SMLC has no signaling links to an STP and needs to access other network entities to which there are no direct point-to-point signaling links.

Where an SMLC supports direct signaling links to one or more MSCs only and has no signaling links to an STP, certain exceptions and modifications to normal CCITT and ANSI requirements may be applied within a PLMN administration.

7.3 SCCP functions

7.3.1 General

For E1 links or where CCITT/ITU SS7 signaling is applicable, the SCCP functions as specified in either CCITT Blue Book Recommendations Q.711, Q.712, Q.713 and Q.714 or ITU White Book Recommendations Q.711, Q.712, Q.713 and Q.714 are applicable, as amended by the exceptions and modifications defined here. For T1 links or where ANSI SS7 signaling is applicable, the SCCP functions as specified in ANSI T1.112 are applicable, as amended by the exceptions and modifications defined here.

Several functions of the SCCP are not used on the Ls interface: error detection, receipt confirmation, flow control.

The segmenting/reassembling function may be used if the total message length exceeds the maximum allowed message length that can be carried by the MTP.

7.3.2 Allowed Exceptions to CCITT Recommendations Q.711-714

Only the following SCCP messages are applicable to the Ls interface:

Connection Confirm (CC)
Connection Request (CR)
Connection Refused (CREF)
Data Form 1 (DT1)
Inactivity Test (IT)
Released (RLSD)
Release Complete (RLC)
Subsystem Allowed (SSA)
Subsystem Prohibited (SSP)
Subsystem Status Test (SST)
Unitdata (UDT)
Unitdata Service (UDTS)

Support of only SCCP protocol classes 0, 1 and 2 is required. For protocol class 2, the "credit" parameter field and the "sequencing/segmenting" parameter fields are not used, but the parameters must still be included in the Inactivity Test (IT) message for syntax reasons. Negotiation of protocol class and flow control is not required for protocol class 2.

The SCCP called party address in a CR or UDT may contain only the subsystem number (SSN) or a signaling point code (SPC) plus SSN or a global title. Use of a global title is not required for SMLC to MSC signaling within the same PLMN. SSN values applicable to the Ls interface are defined in GSM 03.03.

For protocol class 2, support of only a single connection section is required. Use of multiple connection sections is a national concern.

7.3.3 Allowed Exceptions to ANSI T1.112

Only the following SCCP messages are applicable to the Ls interface:

Connection Confirm (CC)
Connection Request (CR)
Connection Refused (CREF)
Data Form 1 (DT1)
Inactivity Test (IT)
Released (RLSD)

Release Complete (RLC)
Subsystem Allowed (SSA)
Subsystem Prohibited (SSP)
Subsystem Status Test (SST)
Unitdata (UDT)
Unitdata Service (UDTS)

Support of only SCCP protocol classes 0, 1 and 2 is required. For protocol class 2, the "credit" parameter field and the "sequencing/segmenting" parameter fields are not used, but the parameters must still be included in the Inactivity Test (IT) message for syntax reasons. Negotiation of protocol class and flow control is not required for protocol class 2.

The SCCP called party address in a CR or UDT may contain only the subsystem number (SSN) or a signaling point code (SPC) plus SSN or a global title. Use of a global title is not required for SMLC to MSC signaling within the same PLMN. SSN values applicable to the Ls interface are defined in GSM 03.03.

For protocol class 2, support of only a single connection section is required. Use of multiple connection sections is a national concern.

7.3.4 Usage of Connectionless SCCP

Connectionless SCCP messages and procedures are used to transfer BSSMAP-LE Connectionless Information messages. Refer to GSM 03.71 for a description of the procedures in the SMLC and MSC. SCCP protocol class 1 shall be used when multiple BSSMAP-LE messages are transferred containing segments of a single fragmented LLP or SMLCPP message.

7.3.5 Usage of Connection Oriented SCCP

Connection oriented SCCP messages and procedures for SCCP protocol class 2 shall be used to transfer BSSMAP-LE positioning messages, BSSMAP-LE LMU control messages, BSSMAP-LE Connection Oriented Information messages and DTAP-LE messages. A separate dedicated SCCP connection shall be used to support either positioning for each target MS or signaling to each type A LMU. Connection establishment shall be instigated when the positioning attempt commences or when a signaling link to a type A LMU needs to be established. Connection release shall be instigated when the positioning attempt has been completed or has failed or when a signaling link to a type A LMU needs to be released. The MSC is normally expected to release the SCCP connection to the SMLC.

Transfer of BSSAP-LE messages within an SCCP connection is shown in the following figure. In particular, a BSSMAP-LE message shall be included in the data field of any SCCP CR and a BSSMAP-LE message may be included in the data fields of an SCCP CC, CREF or RLSD message.

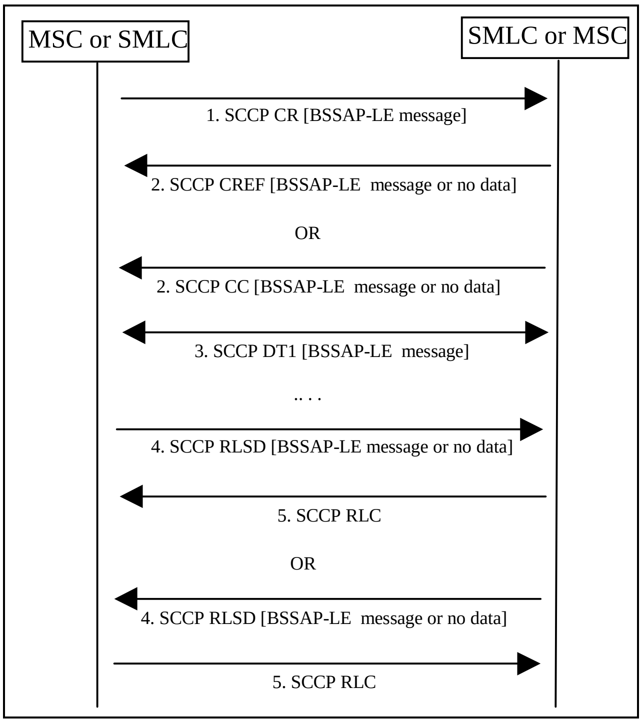


Figure 7.3.5-1/09.31 – SCCP Connection Oriented Signaling on Ls Interface

7.3.6 Contents of the SCCP Data Field

The contents of the SCCP data field for BSSMAP-LE and DTAP-LE messages are shown in the following figures.

	8	7	6	5	4	3	2	1
Octet 1	0	0	0	0	0	0	0	D=0
Octet 2	Length indicator = n							
Octet 3 yo Octet n+2	BSSMAP-LE Message Contents							

Figure 7.3.6-1/GSM 09.31: SCCP Data Field for a BSSMAP-LE Message

	8	7	6	5	4	3	2	1
Octet 1	0	0	0	0	0	0	0	D=1
Octet 2	DLCI							
Octet 3	Length indicator = n							
Octet 4 yo Octet n+3	DTAP-LE Message Contents							

Figure 7.3.6-2/GSM 09.31: SCCP Data Field for a DTAP-LE Message

The Discrimination Indicator is coded in bit 1 of octet one and indicates the type of the BSSAP-LE message.

Discrmination Indicator	BSSAP-LE Message Type
0	BSSMAP-LE
1	DTAP-LE

The DLCI in octet 2 is applicable only to DTAP-LE messages and is coded as defined for the A interface in GSM 08.06 for DTAP. For signaling to a type A LMU using an SDCCH and SAPI=0, the value of the DLCI is 10000000.

The length indicator is coded in one octet, and is the binary representation of the number of octets of the subsequent BSSMAP-LE or DTAP-LE message parameter.

7.3.7 Content of DTAP-LE Messages

DTAP-LE messages transferred on the Ls interface are encoded as defined in GSM 04.71. In particular, in octet 1 of any DTAP-LE message, the Protocol discriminator shall indicate LCS and the transcation identifier (TI) shall indicate the transcation between the SMLC and type A LMU. The TI shall be assigned by the SMLC if the transcation is originated from the SMLC and by the LMU if the originator is the LMU. The MSC shall not change the value of the TI when transferring any DTAP-LE message from the SMLC to the LMU or from the LMU to the SMLC.

8. Use of BSSAP-LE on the Lp Interface

8.1 Applicable Message Sets

The following BSSAP-LE messages are applicable to the Lp interface between an SMLC and a peer SMLC.

BSSMAP-LE Connectionless Information message

8.2 MTP Functions

SS7 signaling on the Lp interface may be supported using 56 kbps or 64 kbps digital signaling channels. These may be supported within either E1 or T1 physical links.

Two SMLCs may be connected by direct point-to-point SS7 signaling links or links may be employed via intermediate STPs. Alternatively, signaling transfer between two SMLCs may be supported via intermediate BSCs and/or MSCs using the Lb and/or Ls interfaces. Signaling requirements to support message transfer on the Lp interface via an intermediate Lb or Ls interface are the same as those defined elsewhere in this specification for these interfaces. This section defines the requirements applicable to direct SMLC-SMLC SS7 links and SS7 links from an SMLC to an STP.

For E1 links or where CCITT/ITU SS7 signaling is applicable, the MTP functions as specified in CCITT Recommendations Q.702, Q.703, Q.704 and Q.707 are applicable. For T1 links or where ANSI SS7 signaling is applicable, the MTP functions as specified in ANSI T1.111 are applicable. Only the requirements in these recommendations for a signaling end point are applicable.

Where an SMLC has no signaling links to an STP, certain exceptions and modifications to normal CCITT and ANSI requirements may be applied within a PLMN administration.

8.3 SCCP functions

8.3.1 General

For E1 links or where CCITT/ITU SS7 signaling is applicable, the SCCP functions as specified in either CCITT Blue Book Recommendations Q.711, Q.712, Q.713 and Q.714 or ITU White Book Recommendations Q.711, Q.712, Q.713 and Q.714 are applicable, as amended by the exceptions and modifications defined here. For T1 links or where ANSI SS7 signaling is applicable, the MTP functions as specified in ANSI T1.112 are applicable, as amended by the exceptions and modifications defined here.

8.3.2 Allowed Exceptions to CCITT Recommendations Q.711-714

Only the following SCCP messages are applicable to the Lp interface:

Inactivity Test (IT)
Subsystem Allowed (SSA)
Subsystem Prohibited (SSP)
Subsystem Status Test (SST)
Unitdata (UDT)
Unitdata Service (UDTS)

Support of only SCCP protocol classes 0 and 1 is required.

The SCCP called party address in a UDT may contain only the subsystem number (SSN) or a signaling point code (SPC) plus SSN or a global title. Use of a global title is not required for SMLC to SMLC signaling within the same PLMN. SSN values applicable to the Lp interface are defined in GSM 03.03.

8.3.3 Allowed Exceptions to ANSI T1.112

Only the following SCCP messages are applicable to the Lp interface:

Inactivity Test (IT)
Subsystem Allowed (SSA)
Subsystem Prohibited (SSP)
Subsystem Status Test (SST)
Unitdata (UDT)
Unitdata Service (UDTS)

Support of only SCCP protocol classes 0 and 1 is required.

The SCCP called party address in a UDT may contain only the subsystem number (SSN) or a signaling point code (SPC) plus SSN or a global title. Use of a global title is not required for SMLC to SMLC signaling within the same PLMN. SSN values applicable to the Lp interface are defined in GSM 03.03.

8.3.4 Usage of Connectionless SCCP

Connectionless SCCP messages and procedures shall be used to transfer BSSMAP-LE Connectionless Information messages. Refer to GSM 03.71 for a description of the procedures in the SMLC. SCCP protocol class 1 shall be used when multiple BSSMAP-LE messages are sent containing segments of a single fragmented SMLCPP message.

8.3.5 Usage of Connection Oriented SCCP

Connection oriented SCCP messages and procedures are not applicable to the Lp interface.

8.3.6 Contents of the SCCP Data Field

The contents of the SCCP data field is shown in the following figure.

	8	7	6	5	4	3	2	1
Octet 1	0	0	0	0	0	0	0	D=0
Octet 2	Length indicator = n							
Octet 3 **yo** **Octet n+2**	BSSMAP-LE Message Contents							

Figure 8.3.6-1/GSM 09.31: SCCP Data Field for a BSSMAP-LE Message

The Discrmination Indicator is coded in bit 1 of octet one and indicates the type of the BSSAP-LE message.

Discrmination Indicator	BSSAP-LE Message Type
0	BSSMAP-LE

The length indicator is coded in one octet, and is the binary representation of the number of octets of the subsequent BSSMAP-LE message parameter.

9. Message Functional Definitions and Contents

9.1 BSSMAP-LE PERFORM LOCATION REQUEST message

This message is sent to request a location estimate for a target MS and contains sufficient information to enable location according to the required QoS using any positioning method supported by the PLMN and, where necessary, MS. The message is also used to request LCS assistance data transfer to an MS or request a deciphering key for LCS broadcast assistance data The message can be sent from the BSC to the SMLC and from the MSC to the SMLC.

Table 9.1: BSSMAP-LE PERFORM LOCATION REQUEST message content

Information element	Type / Reference	Presence	Format	Length in octets
Message type	Message Type 17.1.1.1	M	V	1
Location Type	Location Type	M	TLV	4
Cell Identifier	Cell Identifier	M	TLV	3-10
Classmark Information	Classmark Information	O	TLV	3
LCS Client Type	LCS Client Type	O	TLV	3
Chosen Channel	Chosen Channel	O	TLV	n
LCS Priority	LCS Priority	O	TLV	3
LCS QoS	LCS QoS	O	TLV	6
GPS Assistance Data	GPS Assistance Data	O	TLV	3-n
BSSLAP APDU	APDU	O	TLV	2-n

9.1.1 Location Type

This parameter defines the type of locatin information being requested.

9.1.2 Cell Identifier

This parameter gives the current cell location of the target MS. The format shall either be the cell global identification or the LAC plus CI form.

9.1.3 Classmark Information

This parameter indicates the positioning methods supported by the MS as obtained from the MS Classmark 3 received earlier from the target MS.

9.1.4 LCS Client Type

This parameter defines the type of the originating LCS Client. It may be included to assist an SMLC to appropriately prioritize a location request

9.1.5 Chosen Channel

This parameter defines the type of radio channel currently assigned to the target MS.

9.1.6 LCS Priority

This parameter defines the priority of the location request.

9.1.6 LCS QoS

This parameter provides the required Quality of Service for the LCS Request. Quality of Service may include horizontal accuracy, vertical accuracy and allowed response time.

9.1.7 GPS Assistance Data

This parameter identifies the specific GPS assistance data that may be requested.

9.1.8 BSSLAP APDU

This parameter provides additional measurements (e.g. timing advance) for the target MS from the BSC. The measurements are contained inside a BSSLAP APDU.

9.2 BSSMAP-LE PERFORM LOCATION RESPONSE message

This message is sent in response to a BSSMAP-LE Perform Location Request to return a successful location estimate for a target MS or to indicate some failure in obtaining this. The message is also sent in response to a BSSMAP-LE Perform Location Request to return deciphering keys or an indication that LCS assistance data has been successfully delivered to an MS. The message can be sent from the SMLC to the BSC and from the SMLC to the MSC.

Table 9.2: BSSMAP-LE PERFORM LOCATION RESPONSE message content

Information element	Type / Reference	Presence	Format	Length in octets
Message type	Message Type	M	V	1
Location Estimate	Geographic Location	O	TLV	2-22
Velocity Estimate	Velocity	O	TLV	2-n
Positioning Data	Positioning Data	O	TLV	2-n
Deciphering Key	Deciphering Key	O	TLV	10-n
LCS Cause	LCS Cause	O	TLV	3

9.2.1 Location Estimate

This parameter provides a location estimate for the target MS in the case of a successful location attempt.

9.2.2 Velocity Estimate

This parameter provides a velocity estimate for the target MS.

9.2.3 Positioning Data

This parameter provides additional information for the positioning attempt from the SMLC.

9.2.4 Deciphering Key

This parameter provides one or more deciphering keys that can be used to decode LCS broadcast assitance data by the MS. The SMLC shall provide the current deciphering key for the MS's present location. The SMLC may also provide additional deciphering keys applicable either after the current deciphering key or to data broadcast by other SMLCs.

9.2.5 LCS Cause

The LCS Cause is included if and only if a requested location estimate was not successfully obtained (e.g. location estimate not available or does not meet the required QoS), requested deciphering keys were not successfully returned or requested LCS assistance data was not successfully transferred to the MS. The parameter provides the reason for the failure. If the LCS Cause is included, the Location Estimate, Velocity Estimate, Current Deciphering Key and Next Deciphering Key shall not be included.

9.3 BSSMAP-LE PERFORM LOCATION ABORT message

This message is sent by the instigator of a location request to abort the positioning attempt or the request for assistance data or deciphering keys. This message can be sent from the MSC to the SMLC and from the BSC to the SMLC.

Table 9.3: BSSMAP-LE PERFORM LOCATION ABORT message content

Information element	Type / Reference	Presence	Format	Length in octets
Message type	Message Type	M	V	1
LCS Cause	LCS Cause	M	TLV	3

9.3.1 LCS Cause

The LCS Cause provides the reason for the aborting the location attempt.

9.4 BSSMAP-LE LMU CONNECTION REQUEST message

This message is sent to request the establishment of a signaling connection between an LMU and an SMLC. The message can be sent from an SMLC to an MSC and from an MSC to an SMLC.

Table 9.4: BSSMAP-LE LMU CONNECTION REQUEST message content

Information element	Type / Reference	Presence	Format	Length in octets
Message type	Message Type	M	V	1
IMSI	IMSI	M	TLV	3-10
Sender Address	Signaling Point Code	O	TLV	2-n
Security	Security	O	TLV	2-n
Call Number	ISDN Address	O	TLV	3-n

9.4.1 IMSI

This parameter identifies the LMU using its E.212 IMSI.

9.4.2 Sender Address

This parameter provides the SS7 signaling point code for the sender of the message. The parameter is mandatory for message transfer between an MSC and SMLC on the Ls interface.

9.4.3 Security

This parameter indicates if authentication or ciphering are required for the LMU. This parameter may be included for message transfer from an SMLC. If the parameter is absent, authentication and ciphering shall be assumed not to be required.

9.4.4 Call Number

This parameter may be included in an LMU connection request sent by an MSC to enable the SMLC to subsequently establish a TCH to the LMU.

9.5 BSSMAP-LE LMU CONNECTION ACCEPT message

This message is sent in response to a BSSMAP-LE LMU Connection Request message to accept the establishment of a signaling connection between an LMU and an SMLC. The message can be sent from an SMLC to an MSC and from an MSC to an SMLC.

Table 9.5: BSSMAP-LE LMU CONNECTION ACCEPT message content

Information element	Type / Reference	Presence	Format	Length in octets
Message type	Message Type	M	V	1
Security	Security	O	TLV	3
Call Number	ISDN Address	O	TLV	3-n

9.5.1 Security

This parameter indicates if authentication or ciphering are required for the LMU. This parameter may be included for message transfer from an SMLC. If the parameter is absent, authentication and ciphering shall be assumed not to be required.

9.5.2 Call Number

This parameter may be included in an LMU connection accept sent by an MSC to enable the SMLC to subsequently establish a TCH to the LMU.

9.6 BSSMAP-LE LMU CONNECTION REJECT message

This message is sent in response to a BSSMAP-LE LMU Connection Request message to reject the establishment of a signaling connection between an LMU and an SMLC. The message can be sent from an SMLC to an MSC and from an MSC to an SMLC.

Table 9.6: BSSMAP-LE LMU CONNECTION REQUEST message content

Information element	Type / Reference	Presence	Format	Length in octets
Message type	Message Type	M	V	1
Reject Cause	LMU Cause	M	TLV	3-10

9.6.1 Reject Cause

This parameter provides the reason for the rejection of an LMU connection.

9.7 BSSMAP-LE LMU CONNECTION RELEASE message

This message is sent to release a signaling connection between an LMU and an SMLC. The message can be sent from an SMLC to an MSC and from an MSC to an SMLC.

Table 9.7: BSSMAP-LE LMU CONNECTION RELEASE message content

Information element	Type / Reference	Presence	Format	Length in octets
Message type	Message Type	M	V	1
Release Cause	LMU Cause	M	TLV	3-10

9.7.1 Release Cause

This parameter provides the reason for the release of an LMU connection.

9.8 BSSMAP-LE CONNECTION ORIENTED INFORMATION message

This message is sent in association with an existing signaling connection between an SMLC and another enity to transfer information between the SMLC and other entity belonging to a higher level protocol. The message can be sent from an SMLC to an MSC, from an MSC to an SMLC, from a BSC to an SMLC and from an SMLC to a BSC.

Table 9.8: BSSMAP-LE CONNECTION ORIENTED INFORMATION message content

Information element	Type / Reference	Presence	Format	Length in octets
Message type	Message Type	M	V	1
BSSLAP APDU	APDU	M	TLV	3-n

9.8.1 BSSLAP APDU

This parameter contains a BSSLAP message.

9.9 BSSMAP-LE CONNECTIONLESS INFORMATION message

This message conveys signaling information associated with a higher protocol level between an SMLC and another enity when there is no existing signaling connection association. The message can be sent from an SMLC to an MSC, from an MSC to an SMLC, from a BSC to an SMLC, from an SMLC to a BSC and from an SMLC to another SMLC..

Table 9.9: BSSMAP-LE CONNECTIONLESS INFORMATION message content

Information element	Type / Reference	Presence	Format	Length in octets
Message type	Message Type	M	V	1
Source Identity	Network Element Identity	M	TLV	3-n
Destination Identity	Network Element Identity	M	TLV	3-n
Return Error Request	Return Error Request	O	TLV	2
Return Error Cause	Return Error Cause	O	TLV	3
APDU	APDU	O	TLV	3-n

9.9.1 Source Identity

This parameter identifies the original source of the message. The original source can either be an SMLC or a Type B LMU. The source is identified by association with either a location area or a cell site.

9.9.2 Destination Identity

This parameter identifies the final destination of the message. The final destination can either be an SMLC or a Type B LMU. The destination is identified by association with either a location area or a cell site.

9.9.3 Return Error Request

This pareameter may be included to request an error response if BSSMAP-LE message cannot be delivered successfully to its final destination. This parameter shall not be included if the Return Error cause is present.

9.9.4 Return Error Cause

This parameter indicates an error response for a BSSMAP-LE connectionless information message that could not be delivered to its final destination. The APDU should be present and the same as the APDU in the original undelivered message. The source and destination identies shall be included and the same as the destination and source identities, respectively, in the original undelivered message.

9.9.5 APDU

This parameter contains an embedded APDU. For information transfer between an SMLC and Type B LMU this shall be an LLP APDU. For information transfer between two peer SMLCs, this shall be an SMLCPP APDU.

10. Message format and information element coding

This clause specifies the coding of the Information Elements used by the BSSAP-LE protocol. The spare bits in the coding of an IE shall be set to zero by the sender and shall be ignored by the receiver.

All unassigned codes (whether omitted or explicitely *Unassigned* in the text) shall be treated as unknown (see clause ‘Error Handling and Future Compatibility’).

The following conventions are assumed for the sequence of transmission of bits and bytes:

- Each bit position is marked as 1 to 8. Bit 1 is the least significant bit and is transmitted first.
- In an element octets are identified by number, octet 1 is transmitted first, then octet 2 etc.

When a field extends over more than one octet, the order of bit values progressively decreases as the octet number increases. The least significant bit of the field is represented by the lowest numbered bit of the highest numbered octet of the field.

- For variable length elements a length indicator is included, this indicates the number of octets following in the element.
- All fields within Information Elements are mandatory unless otherwise specified. The Information Element Identifier shall always be included.

All spare bits are set to 0.

For any information element of format TLV, the length indicator octet, as in GSM 08.08, defines the number of octets in the information element that follow the length indicator octet.

10.1 Message type

Message type uniquely identifies the message being sent. It is a single octet element, mandatory in all messages.

Table 10.1/GSM 09.31: Message type information element

Category	8 7 6 5 4 3 2 1	Message Type
	0 0 0 0 0 0 0 0	Reserved.
POSITIONING MESSAGES		
	0 0 1 0 1 1 0 1	BSSMAP-LE PERFORM LOCATION REQUEST
	0 0 1 0 1 1 1 0	BSSMAP-LE PERFORM LOCATION RESPONSE
	0 0 1 0 1 1 1 1	BSSMAP-LE PERFORM LOCATION ABORT
LMU CONTROL MESSAGES		
	0 0 0 0 0 0 0 0	BSSMAP-LE LMU CONNECTION REQUEST
	0 0 0 0 0 0 0 1	BSSMAP-LE LMU CONNECTION ACCEPT
	0 0 0 0 0 0 1 0	BSSMAP-LE LMU CONNECTION REJECT
	0 0 0 0 0 0 1 1	BSSMAP-LE LMU CONNECTION RELEASE
INFORMATION MESSAGES		
	0 0 1 0 1 0 1 0	BSSMAP-LE CONNECTION ORIENTED INFORMATION
	0 0 1 1 1 0 1 0	BSSMAP-LE CONNECTIONLESS INFORMATION

10.2 Information Element Identifiers

The next list shows the coding of the Information Element Identifiers used in the present document.

Table 10.2/GSM 09.31: Information Element Identifier coding

8 7 6 5 4 3 2 1	**Information element**	*Reference*
0 0 1 1 1 1 1 1	LCS QoS	*10.15*
0 1 0 0 0 0 1 1	LCS Priority	*10.14*
0 1 0 0 0 1 0 0	Location Type	*10.16*
0 1 0 0 0 1 0 1	Geographic Location	*10.8*
0 1 0 0 0 1 1 0	Positioning Data	*10.18*
0 1 0 0 0 1 1 1	LCS Cause	*10.12*
0 1 0 0 1 0 0 0	LCS Client Type	*10.13*
0 1 0 0 1 0 0 1	APDU	*10.3*
0 1 0 0 1 0 1 0	Velocity	*10.23*
0 1 0 0 1 0 1 1	Network Element Identity	*10.17*
0 1 0 0 1 1 0 0	GPS Assistance Data	*10.9*
0 1 0 0 1 1 0 1	Deciphering Key	*10.7*
0 0 0 0 0 0 0 0	Cell Identifier	*10.4*
0 0 0 0 0 0 0 1	Chosen Channel	*10.5*
0 0 0 0 0 0 1 0	Classmark Information	*10.6*
0 0 0 0 0 0 1 1	IMSI	*10.10*
0 0 0 0 0 1 0 0	ISDN Address	*10.11*
0 0 0 0 0 1 0 1	Return Error Cause	*10.19*
0 0 0 0 0 1 1 0	Return Error Request	*10.20*
0 0 0 0 0 1 1 1	Security	*10.21*
0 0 0 0 1 0 0 0	Signaling Point Code	*10.22*

10.3 APDU

This is a variable length information element that conveys an embedded message or message segment associated with a higher level protocol.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	S	Protocol ID						
Octet 4 to Octet n	The rest of the information element contains a message whose content and encoding are defined according to the protocol ID.							

Figure 10.3.1/GSM 09.31: APDU IE

Protocol ID (bits 7-1 of octet 3)

0000000 reserved
0000001 BSSLAP
0000010 LLP
0000011 SMLCPP

S (Segmentation Bit, bit 8 of octet 3)

0 final segment in a segmented message or a non-segmented message or segmenting not indicated
1 non-final segment in a segmented message

Embedded Message (octets 4-n)

BSSLAP the embedded message is as defined in GSM 08.71
LLP the embedded message contains a Facility Information Element as defined in GSM 04.71 excluding the Facility IEI and length of Facility IEI octets defined in GSM 04.71.

SMLCPP the embedded message is as defined in GSM 08.31

10.4 Cell Identifier

This is a variable length information element identifying a particular cell.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	The rest of the information element is coded as the value part of the Cell Identifier IE defined in GSM 08.08.							

Figure 10.4.1/GSM 09.31: Cell Identifier IE

10.5 Chosen Channel

This information element identifiers a type of radio interface channel..

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	The rest of the information element is coded as the value part of the Chosen Channel IE defined in GSM 08.08.							

Figure 10.5.1/GSM 09.31: Chosen Channel IE

10.6 Classmark Information

This information element contains classmark information for a target MS obtained from the MS Classmark 3 defined in GSM 04.08.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	spare			E	D	C	B	A

Figure 10.6.1/GSM 09.31: Classmark Information IE

Octet 3

bit A MS assisted E-OTD
0 : MS assisted E-OTD is not supported
1 : MS assisted E-OTD is supported

bit B MS based E-OTD
0 : MS based E-OTD is not supported
1 : MS based E-OTD is supported

bit C MS assisted GPS
0 : MS assisted GPS is not supported
1 : MS assisted GPS is supported

bit D MS based GPS~~E-OTD~~
0 : MS based GPS is not supported
1 : MS based GPS is supported

bit E conventional GPS
0 : conventional GPS is not supported
1 : conventional GPS is supported

10.7 Deciphering Key

This variable length information element defines the deciphering key or keys which should used by the MS to decode LCS broadcast assistance data. The parameter includes at least one diciphering key data field.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	Ciphering Algorithm and Key Length							
Octets 4 – 4+m	Deciphering Key Data 1							
. . .	. . .							
Octets n*m + n – m + 3 to n*m + n + 3	Deciphering Key Data n							

where m = deciphering key length in octets

Figure 10.7.1/GSM 09.31: Deciphering Key IE

Ciphering Algorithm and Key Length (octet 3)
This binary field defines the ciphering algorithm and the length of the deciphering key as follows

00000000 reserved
00000001 DES algorithm using 56 bit (7 octet) deciphering key
other values reserved

	8	7	6	5	4	3	2	1
Octet x+1	Key Identifier							
Octet x+2 … **Octet x+m+1**	Deciphering Key Value							

where x = n*i + n – i + 2 for i'th deciphering key data field

Figure 10.7.2/GSM 09.31: Deciphering Key Data

Key identifier (octet x+1)
This field identifies the deciphering key. The identifier is included unciphered in the broadcast data. The field consists of two binary codes:

bits 8-6 : SMLC identifier
bits 5-1 : key identifier for a particular SMLC

Deciphering key value (octets x+2 to x+m+1)
This field contains the m octet~~56 bit~~ deciphering key which should be used to decode LCS broadcast assistance data. The high order bit is in bit 8 of octet x+2; the low order bit is in bit 1 of octet x+m+1.

10.8 Geographic Location

This is a variable length information element providing an estimate of a geographic location.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3 to Octet n	The rest of the information element contains an octet sequence identical to that for the Ext-GeographicalInformation data type in GSM 09.02.							

Figure 10.8.1/GSM 09.31: Geographic Location IE

10.9 GPS Assistance Data

~~**Editorial Note: this parameter is proposed by Nokia and is consistent with an equivalent parameter in GSM 04.30 (MO-LR).**~~

This is a variable length information element identifying the GPS assistance data requested for an MS.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	spare					Eph	ACQ	SAT
Octet 4 to Octet 7+2n	Satellite related data							

Figure 10.9.1/GSM 09.31: GPS Assistance Data IE

SAT – Satellite related data (bit 1 of octet 3)

0 : Satellite related data is not requested – octets 4 to 7+2n are not present
1 : Satellite related data is requested – octets 4 to 7+2n are present

ACQ – Acquisition Assistance (bit 2 of octet 3)

0 : Acquisition Assistance is not requested
1 : Acquisition Assistance is requested

Eph – Ephemeris Compression (bit 3 of octet 3~~octet 1, bit 3~~)
This field indicates the compression method for ephemeris update.

0: Ephemeris compression can be incorporated into requested Navigation Model information.
1: Ephemeris compression cannot be incorporated in requested Navigation Model information.

	8	7	6	5	4	3	2	1
Octet 4	H	G	F	E	D	C	B	A
Octet 5	GPS Week		spare					
Octet 6	GPS Week							
Octet 7	Spare	NSAT				T-Toe limit		
Octet 8	spare		SatID 1					
Octet 9	IODE 1							
…								
Octet 6+2n	spare		SatID n					
Octet 7+2n	IODE n							

Figure 10.9.2/GSM 09.31: Coding of Satellite Related Data

Octets 4 and 5

bit A Almanac
0 : Almanac is not requested
1 : Almanac is requested

bit B UTC Model
0 : UTC Model is not requested
1 : UTC Model is requested

bit C Ionospheric Model
0 : Ionospheric Model is not requested
1 : Ionospheric Model is requested

bit D Navigation Model
0 : Navigation Model is not requested
1 : Navigation Model is requested

bit E DGPS Corrections
0 : DGPS Corrections are not requested
1 : DGPS Corrections are requested

bit F Reference Location
0 : Reference Location is not requested
1 : Reference Location is requested

bit G Reference Time
0 : Reference Time is not requested
1 : Reference Time is requested

bit H spare

At least one of bits A, B, C, D, E, F, or G shall be set to the value “1”.

GPS Week (bits 7-8 octet 5 and octet 6)
This field contains a 10 bit binary representation of the GPS Week of the assistance currently held by the MS. The most significant bit of the GPS Week is bit 8 in octet 5 and the least significant bit is bit 1 in octet 6.

NSAT (octet 7, bits 4-7)
This field containss a binary representation of the number of satellites to be considered for the current GPS assistance request.

T-Toe limit (octet 7, bits 1-3)
This field contains a binary representation of the ephemeris age tolerance of the MS to the network in hours.

SatID x (x = 1,2, ... n) (octet 6 + 2x, bits 1-6)
This field contains a binary representation of the identity of a satellite for which the assistance request is applicable. The number of satellite fields is indicated in the field NSAT.

IODE x (x = 1,2, ... n) (octet 7 + 2x)
This field contains a binary representation of the Issue of Data Ephemeris, which identifies the sequence number for the satellite x (x = 1, 2, …, n).

10.10 IMSI

The IMSI is of variable length and is coded as a sequence of BCD digits, compressed two into each octet. This is a variable length element, and includes a length indicator. The IMSI is defined in GSM 03.03. It shall not exceed 15 digits (see GSM 03.03).

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	IMSI digit 1				odd/ even	0	0	0
Octet 4	IMSI digit 3				IMSI digit 2			
Octet 4+x	IMSI digit i+1				IMSI digit i			

Figure 10.10.1/GSM 09.31: IMSI IE

Where x = (i-2)/2 and i is always even

* The value of the odd/even bit (bit 4 in octect 3) indicates:

0 Even number of IMSI digits

1 Odd number of IMSI digits

If the number of IMSI digits is even then bits 5 to 8 of the last octet shall be filled with an end mark coded as 1111.

10.11 ISDN Address

This information element contains an ISDN address.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	The rest of the information element contains an octet string coded the same as the ISDN-AddressString common data type defined in GSM 09.02							

Figure 10.11.1/GSM 09.31: ISDN Address IE

10.12 LCS Cause

The LCS Cause parameter is of variable length IE and provides the reason for an unsuccessful location request.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	Cause value							
Octet 4	Diagnostic value (note 1)							

note 1: the inclusion of this octet depends on the cause value

Figure 10.12.1/GSM 09.31: LCS Cause IE

Table 10.12.1/GSM 09.31: Cause value

LCS Cause value (octet 2)	
Bits	
8 7 6 5 4 3 2 1	
0 0 0 0 0 0 0 0	Unspecified
0 0 0 0 0 0 0 1	System Failure
0 0 0 0 0 0 1 0	Protocol Error
0 0 0 0 0 0 1 1	Data missing in position request
0 0 0 0 0 1 0 0	Unexpected data value in position request
0 0 0 0 0 1 0 1	Position method failure
0 0 0 0 0 1 1 0	Target MS Unreachable
0 0 0 0 0 1 1 1	Location request aborted
0 0 0 0 1 0 0 0 to 1 1 1 1 1 1 1 1	*unspecified* in this version of the protocol

Diagnostic value (octet 4): this octet may be included if the cause value indicates "position method failure", the binary encoding of this octet shall encode the same set of values as defined for the PositionMethodFailure-Diagnostic in GSM 09.02. Values outside those defined in GSM 09.02 shall be ignored by a receiver.

10.13 LCS Client Type

This information element identifies the type of LCS Client.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	Client Category				Client Subtype			

Figure 10.13.1/GSM 09.31: LCS Client Type IE

The client category (bits 8-5 of octet 2) and the client subtype (bits 4-1 of octet 2) are coded as follows.

Client Category	Client Subtype	Explanation
0000		Value Added Client
	0000	unspecified
	all values	reserved
0010		PLMN operator
	0000	unspecified
	0001	broadcast service
	0010	O&M
	0011	anonymous statistics
	0100	Target MS service support
	other values	reserved
0011		Emergency services
	0000	unspecified
	other values	reserved
0100		Lawful Intercept services
	0000	unspecified
	other values	reserved
0101 – 1111	all values	reserved

10.14 LCS Priority

This information element defines the priority level of a location request.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	This octet is coded as the LCS-Priority octet in GSM 09.02.							

Figure 10.14.1/GSM 09.31: LCS Priority IE

10.15 LCS QoS

This information element defines the Quality of Service for a location request.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	spare							VERT
Octet 4	HA	Horizontal Accuracy						
Octet 5	VA	Vertical Accuracy						
Octet 6	RT		spare					

Figure 10.15.1/GSM 09.31: Cell Identifier IE

Octet 3
VERT = vertical coordinate indicator
0 : vertical coordinate not requested
1 : vertical coordinate (and vertical component for velocity if applicable) are requested

Octet 4
bit 8 HA = horizontal accuracy indicator
0 : Horizontal Accuracy is not specified
1 : Horizontal Accuracy is specified
bits 7-1 Horizontal Accuracy :
spare (set all zeroes) if HA=0
set to 7 bit uncertainty code in GSM 03.32 if HA=1

Octet 5 – applicable only if VERT = 1
bit 8 VA = vertical accuracy indicator
0 : Vertical Accuracy is not specified
1 : Vertical Accuracy is specified
bits 7-1 Vertical Accuracy :
spare (set all zeroes) if VA=0
set to 7 bit uncertainty altitude code in GSM 03.32 if VA=1

Octet 6
bits 8-7 RT = response time category
00 : Response Time is not specified
01 : Low Delay
10 : Delay Tolerant
11 : reserved
bits 6-1 spare

10.16 Location Type

This is a variable length information element defining the type of location information being requested.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	Location Information							
Octet 4	Positioning Method							

Figure 10.16.1/GSM 09.31: Location Type IE

Coding of location information (octet 3):

00000000 current geographic location
00000001 current geographic location and velocity
00000010 location assistance information for the target MS
00000011 deciphering key for broadcast assistance data for the target MS
all other values are reserved

Positioning Method (octet 4)
This octet shall be included if the location information in octet 3 indicates “location assistance information for the target MS” and shall be omitted otherwise.

00000000 reserved
00000001 Mobile Assisted E-OTD
00000010 Mobile Based E-OTD
00000011 GPS
all other values are reserved

10.17 Network Element Identity

This is a variable length information element identifying a network element. by association with either a designated cell site or a designated location area.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	spare				Identity Discrminator			
Octet 4 to Octet n	Network Element Identification							

Figure 10.17.1/GSM 09.31: Network Element Identity IE

Identity Discriminator (bits 4-1 of octet 3)
0000 Identification using the LAC as defined in GSM 03.03
0001 Identification using LAC + CI as defined in GSM 03.03

	8	7	6	5	4	3	2	1
Octet 4	LAC							
Octet 5	LAC - continued							

Figure 10.17.2/GSM 09.31: Coding of Network Element Identification using the LAC

	8	7	6	5	4	3	2	1
Octet 4	LAC							
Octet 5	LAC – continued							
Octet 6	CI value							
Octet 7	CI value - continued							

Figure 10.17.3/GSM 09.31: Coding of Network Element Identification using the LAC + CI

10.18 Positioning Data

This is a variable length information element providing positioning data associated with a successful or unsuccessful locatiomn attempt for a target MS.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	spare				Positioning Data Discriminator			
Octets 4-4+m	Positioning Method 1							
Octets ..-4+nm	Positioning Method n							

Figure 10.18.1/GSM 09.31: Positioning Data IE

The positioning data discrminator (bits 4-1 of octet 3) defines the type of data provided for each positioning method:

0000 indicate usage of each positioning method that was attempted either successfully or unsuccessfully
all other values are reserved

Coding of the postioning method octets for positioning data discrminator = 0:

Octet x	positioning method	usage

Coding of positioning method (bits 8-4~~5~~):

00000 Timing Advance
00001 TOA
00010 AOA
00011 Mobile Assisted E-OTD
00100 Mobile Based E-OTD
00101 Mobile Assisted GPS
00110 Mobile Based GPS
00111 Conventional GPS
01000
to reserved for GSM
01111
10000
to reserved for network specific positioning methods
11111

Coding of usage (bits 3~~4~~-1)

~~0~~000 Attempted unsuccessfully due to failure or interruption
~~0~~001 Attempted successfully: results not used to generate location (or velocity)
~~0~~010 Attempted successfully: results used to verify but not generate location (and velocity)
~~0~~011 Attempted successfully: results used to generate location (and/or velocity)
~~0~~100 Attempted successfully: case where MS supports multiple mobile based positioning methods and the actual method or methods used by the MS cannot be determined

10.19 Return Error Cause

The Return Error Cause parameter provides the reason for unsuccessful delivery of a BSSMAP-LE Connectionless Information message to its final destination.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	Cause value							

Figure 10.19.1/GSM 09.31: Return Error Cause IE

Table 10.19.1/GSM 09.31: Cause value

Cause value (octet 2)	
Bits	
8 7 6 5 4 3 2 1	
0 0 0 0 0 0 0 0	Unspecified
0 0 0 0 0 0 0 1	System Failure
0 0 0 0 0 0 1 0	Protocol Error
0 0 0 0 0 0 1 1	Destination unknown
0 0 0 0 0 1 0 0	Destination unreachable
0 0 0 0 0 1 0 1	Congestion
0 0 0 0 0 1 1 0 to 1 1 1 1 1 1 1 1	*unspecified* in this version of the protocol

10.20 Return Error Request

The Return Error Request parameter indicates a request from the source of a BSSMAP-LE connectionless information message for an error response if the message cannot be delivered to its final destination.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							

Figure 10.20.1/GSM 09.31: Return Error Request IE

10.21 Security

This information element defines what security measures are needed for signaling to an LMU.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3	spare						CIPH	AUTH

Figure 10.21.1/GSM 09.31: Security IE

Coding of octet 3:

bit 1 AUTH = authentication indicator
0 : authentication of LMU not required
1 : authentication of LMU required

bit 2 CIPH = ciphering indicator
0 : ciphering of LMU signaling data not required
1 : ciphering of LMU signaling data required

10.22 Signaling Point Code

This is a variable length information element providing that provides the signaling point code of a network element.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octets 3-n	Signaling Point Code value							

Figure 10.22.1/GSM 09.31: Signaling Point Code IE

There are three options for the coding of Signaling Point Code value; 2 octets containing a 14 bit ITU code, 3 octets containing a 24 bit unstructured code and 3 octets containing a 24 bit ANSI structured code.

Encoding of 14 bit ITU signaling point code:

Octet 3	0	0	signaling point code (high order bits)
Octets 4	signaling point code (low order bits)		

Encoding of a 24 bit unstructured signaling point code:

Octet 3	signaling point code (high order octet)
Octet 4	signaling point (second octet)
Octets 5	signaling point code (low order octet)

Encoding of a 24 bit ANSI structured signaling point code:

Octet 3	Network Identifier
Octet 4	Network Cluster
Octets 5	Network Cluster Member

10.23 Velocity

This is a variable length information element providing an estimate of the velocity of a target MS.

	8	7	6	5	4	3	2	1
Octet 1	IEI							
Octet 2	Length indicator							
Octet 3 to Octet n	The rest of the information element contains an octet sequence applicable to the Velocity information defined in GSM 03.32.							

Figure 10.23/GSM 09.31: Velocity IE

Annex A (informative): Document Change Request History

Document history		
1.0.0	16/9/99	Initial version from Siemens to T1P1.5 – last updated for 11/10/99

History

Document history		