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1

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*Technical Specification*

## 3rd Generation Partnership Project;
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## Functional stage 2 description of LCS
## (Release 2000)

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# Contents

# Foreword

This Technical Specification (TS) has been produced by the 3$^{rd}$ Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x    the first digit:

1    presented to TSG for information;

2    presented to TSG for approval;

3    or greater indicates TSG approved document under change control.

y    the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z    the third digit is incremented when editorial only changes have been incorporated in the document.

# 2 Scope

The present document specifies the stage 2 of the LoCation Services (LCS) feature in UMTS and GSM, which provides the mechanisms to support mobile location services for operators, subscribers and third party service providers.

This specification TS 23.271 replaces the specifications TS 23.171 (Release 99) and GSM 03.71 in Release 4.

Location Services may be considered as a network provided enabling technology consisting of standardised service capabilities, which enable the provision of location applications. The application(s) may be service provider specific. The description of the numerous and varied possible location applications which are enabled by this technology are outside the scope of the present document. However, clarifying examples of how the functionality being described may be used to provide specific location services may be included.

This stage 2 service description covers the LCS system functional model for the whole system, the LCS system architecture, state descriptions, message flows, etc.

# 3 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.

## 3.1 Normative references

[1] 3G TR 25.305: "Functional stage 2 specification of location services in UTRAN".

[2] GSM 01.04 (ETR 350): "Abbreviations and acronyms".

[3] 3G TS 21.905: "UMTS Abbreviations and acronyms".

[4] TS 22.071: "Location Services (LCS); Service description, Stage 1".

[5] GSM 03.71: "Location Services (LCS); (Functional description) - Stage 2".

[6] GSM 03.32: "Universal Geographical Area Description".

[7] 3G TS 22.100: "UMTS phase 1 Release 99".

[8] 3G TS 22.101: "Service principles".

[9] 3G TS 22.105: "Services and Service Capabilities".

[10] 3G TS 22.115: "Charging and Billing".

[11] TS 23.032: "Universal Geographical Area Description (GAD)"

[12] 3G TS 22.121: "The Virtual Home Environment".

[13] 3G TS 23.110: "UMTS Access Stratum; Services and Functions".

[14] 3G TS 25.413: "UTRAN Iu Interface RANAP signalling".

[15] 3G TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[16] 3G TS 43.059: " Functional Stage 2 description of Location Services in GERAN".

[17]        [More references to GSM specifications should be added.]

[18]        3G TS 23.003: "Numbering, addressing and identification"

[19]        3G TS 23.060: "General Packet Radio Service (GPRS);Service description Stage 2"

## 3.2     Informative references

[20]        Third generation (3G) mobile communication system; Technical study report on the location services and technologies, ARIB ST9 December 1998.

[21]        The North American Interest Group of the GSM MoU ASSOCIATION: Location Based Services, Service Requirements Document of the Services Working Group.

# 4     Definitions and abbreviations

## 4.1     Definitions

For the purposes of the present document, the following terms and definitions apply:

**CAMEL:** CAMEL is a network functionality, which provides the mechanisms of Intelligent Network to a mobile user

**Call Related:** Any LCS related operation which is associated with an established call in CS domain and a session via an active PDP context in PS domain.
NOTE: A possible separate class for active PDP context is for further study.

**Current Location:** after a location attempt has successfully delivered a location estimate and its associated time stamp, the location estimate and time stamp is referred to as the "current location" at that point in time

**Deferred location request:** a location request where the location response (responses) is (are) not required immediately

**Global Positioning System:** the Global Positioning System (GPS) consists of three functional elements: Space Segment (satellites), User Segment (receivers), and Control Segment (maintenance etc.). The GPS receiver calculates its own position based on the received time differences for several satellites

**Immediate location request:** a location request where a single location response only is required immediately

**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"

**Last Known Location:** the current location estimate and its associated time stamp for Target MS stored in the LCS Server is referred to as the "last known location" and until replaced by a later location estimate and a new time stamp is referred to as the "last known location"

**LCS (LoCation Services):** LCS is a service concept in system (e.g. GSM or UMTS) standardization. LCS specifies all the necessary network elements and entities, their functionalities, interfaces, as well as communication messages, due to implement the positioning functionality in a cellular network. Note that LCS does not specify any location based (value added) services except locating of emergency calls

**LCS Client:** a software and/or hardware entity that interacts with a LCS Server for the purpose of obtaining location information for one or more Mobile Stations. LCS Clients subscribe to LCS in order to obtain location information. LCS Clients may or may not interact with human users. The LCS Client is responsible for formatting and presenting data and managing the user interface (dialogue). The LCS Client may reside in the Mobile Station (MS)

**LCS Client Access barring list:** an optional list of MSISDNs per LCS Client where the LCS Client is not allowed to locate any MSISDN therein

**LCS Client Subscription Profile:** a collection of subscription attributes of LCS related parameters that have been agreed for a contractual period of time between the LCS client and the service provider.

**LCS Feature:** the capability of a PLMN to support LCS Client/server interactions for locating Target MSs

**LCS Server:** a software and/or hardware entity offering LCS capabilities. The LCS Server accepts requests, services requests, and sends back responses to the received requests. The LCS server consists of LCS components, which are distributed to one or more PLMN and/or service provider

**Local Service:** a service, which can be exclusively provided in the current serving network by a Value added Service Provider

**Local Information:** information related to a given location, or general information, which is made available in a given location

**Location (Based) Application:** a location application is an application software processing location information or utilizing it in some way. The location information can be input by a user or detected by network or MS. Navigation is one location application example

**Location Based Service (LBS):** a service provided either by teleoperator or a 3$^{rd}$ party service provider that utilizes the available location information of the terminal. Location Application offers the User Interface for the service. LBS is either a pull or a push type of service (see Location Dependent Services and Location Independent Services). In ETSI/GSM documentation of SoLSA, LBS is called "Location Related Service". ETSI and/or 3GPP –wide terminology harmonization is expected here

**Location Dependent Service:** a service provided either by teleoperator or a 3$^{rd}$ party service provider that is available (pull type) or is activated (push type) when the user arrives to a certain area. It doesn't require any subscription in advance, but the push type activation shall be confirmed by the user. The offered service itself can be any kind of service (e.g. a public Xerox machine or the discount list in a store)

**Location Estimate:** the geographic location of an MS and/or a valid Mobile Equipment (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

**Location Independent Service:** a service provided either by teleoperator or a 3$^{rd}$ party service provider that is available and therefore can be activated anywhere in the network coverage. It is activated by the user's request or by other user's activated service, and therefore it requires a subscription in advance (pull type). The offered service itself can be any kind of service (e.g. MMS, SWDL, or LBS!)

**Mobile Assisted positioning:** any mobile centric positioning method (e.g. IPDL-OTDOA, 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. IPDL-OTDOA, 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 are not considered within this category

**Mobile Station:** the mobile station (MS) consists of Mobile or User Equipment (ME or UE) with a valid SIM or USIM attached. Mobile station (MS) in this specification may also refer to a Mobile Equipment or User Equipment used for emergency calls, that do not have valid SIM or USIM.

**PLMN Access barring list:** an optional list of MSISDN per PLMN where any LCS Client is not allowed to locate any MSISDN therein except for certain exceptional cases

**Positioning (/location detecting):** positioning is a functionality, which detects a geographical location (of e.g. a mobile terminal)

**Positioning method (/locating method):** a principle and/or algorithm which the estimation of geographical location is based on, e.g. AOA, TOA, TDOA. For example, GPS is based on TOA, whilst OTDOA and E-OTD (on GSM) are based on TDOA

**Positioning technology (/locating technology):** a technology or system concept including the specifications of RF interfaces, data types, etc. to process the estimation of a geographical location, e.g. GPS, E-OTD (GSM), and OTDOA (WCDMA)

**Predefined area:** a geographical area which is not related to cell or radio coverage. The mobile may take special action when it recognises it has entered or left a predefined area

**Privacy Class:** list of LCS Clients defined within a privacy exception class to which permission may be granted to locate the target MS. The permission shall be granted either on activation by the target MS or permanently for a contractual period of time agreed between the target MS and the service provider

**Privacy Exception List:** a list consisting of various types of privacy classes (i.e. operator related, personal etc.). Certain types of classes may require agreement between the service provider and the target MS

**Prohibited area:** an area where the mobile must not activate its transmitter. The Prohibited area may be a Predefined area described above or related to radio cell(s)

**Subscription Profile:** the profile detailing the subscription to various types of privacy classes

**Target MS:** the MS being positioned

**User Equipment:** The term 'User Equipment', or 'UE,' should for GSM be interpreted as 'MS', as defined in GSM TS 04.02.

Further UMTS related definitions are given in 3G TS 22.101.

> Editor's note: The terms "In GSM" and "In UMTS" need to be defined as in 24.008.
> Also, there was an agreement between S2 and N1 at the last meeting, to replace the terms "In GSM" and "In UMTS" in the R99/R00 specifications to "in A/Gb mode" and "in Iu mode". But, it seems that S1 has also been discussing this issue via e-mail and may be suggesting other terms. When a decision is finally made to replace these terms they need to be changed in this document.

# 4.2 Symbols

For the purposes of the present document, the following symbols apply:

| | |
|---|---|
| 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 - VMSC, GMLC - MSC Server, GMLC - SGSN (gateway MLC interface) |
| | |
| Um | GERAN Air Interface |
| Uu | UTRAN Air Interface |

# 4.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

| | |
|---|---|
| 2G- | Second Generation |
| 3G- | Third Generation |
| MSC | Mobile Services switching Center |
| SGSN | Serving GPRS Support Node |
| AC | Admission Control |
| AI | Application Interface (prefix to interface class method) |
| ANM | Answer Message (ISUP) |
| APN | Access Point Name |

| | |
|---|---|
| ARIB | Association of Radio Industries and Business |
| ATD | Absolute Time Difference |
| BCCH | Broadcast Control Channel |
| BER | Bit Error Rate |
| BTS | Base Transceiver Station |
| BSS | Base Station Subsystem |
| CAMEL | Customised Application For Mobile Network Enhanced Logic |
| CAP | CAMEL Application Part |
| CM | Connection Management |
| CN | Core Network |
| CSE | Camel Service Environment |
| DL | Downlink |
| DRNC | Drift RNC |
| E-OTD | Enhanced Observed Time Difference |
| FER | Frame Error Rate |
| GERAN | GSM EDGE Radio Access Network |
| GGSN | Gateway GPRS Support Node |
| GMLC | Gateway MLC |
| GPRS | General Packet Radio Service |
| GPS | Global Positioning System |
| HE | Home Environment |
| HLR | Home Location Register |
| HPLMN | Home Public Land Mobile Network |
| IMEI | International Mobile Equipment Identity |
| IMSI | International Mobile Subscriber Identity |
| IP | Internet Protocol |
| IPDL | Idle Period Downlink |
| LA | Location Application |
| LAF | Location Application Function |
| LBS | Location Based Services |
| LCAF | Location Client Authorization Function |
| LCCF | Location Client Control Function |
| LCCTF | Location Client Co-ordinate Transformation Function |
| LCF | Location Client Function |
| LCS | LoCation Services |
| LDR | Location Deferred Request |
| LIR | Location Immediate Request, |
| LMU | Location Measurement Unit |
| LSAF | Location Subscriber Authorization Function |
| LSBF | Location System Billing Function |
| LSBcF | Location System Broadcast Function |
| LSCF | Location System Control Function |
| LSOF | Location System Operation Function |
| LSPF | Location Subscriber Privacy Function |
| MAP | Mobile Application Part |
| ME | Mobile Equipment |
| MExE | Mobile Execution Environment |
| MLC | Mobile Location Center |
| MM | Mobility Management |
| MO-LR | Mobile Originated Location Request |
| MS | Mobile Station MSC Mobile services Switching Centre |
| MSISDN | Mobile Station Integrated Services Data Network |
| MT-LR | Mobile Terminated Location Request |
| NI-LR | Network Induced Location Request |
| OSA | Open Service Architecture |
| OTDOA | Observed Time Difference Of Arrival |
| PC | Power Control |
| PCF | Power Calculation Function |
| PLMN | Public Land Mobile Network |
| POI | Privacy Override Indicator |
| PRCF | Positioning Radio Co-ordination Function |
| PRRM | Positioning Radio Resource Management |

| PSE | Personal Service Environment |
|---|---|
| PSMF | Positioning Signal Measurement Function |
| PSTN | Public Switched Telephone Network |
| QoS | Quality of Service |
| RA | Routing Area |
| RACH | Random Access Channel |
| RAN | Radio Access Network |
| RANAP | Radio Access Network Application Part |
| RIS | Radio Interface Synchronization |
| RNC | Radio Network Controller |
| RRM | Radio Resource Management |
| RTD | Real Time Difference |
| SAT | SIM Application Tool-Kit |
| SGSN | Serving GPRS Support Node |
| SI | Service Interface (prefix to interface class method) |
| SIM | Subscriber Identity Module |
| SLPP | Subscriber LCS Privacy Profile |
| SMS | Short Message Service |
| SIR | Signal Interference Ratio |
| SP | Service Point |
| SRNC | Serving RNC |
| SS7 | Signalling System No 7 |
| TA | Timing Advance |
| TMSI | Temporary Mobile Subscriber Identity |
| TOA | Time Of Arrival |
| | |
| UDT | SCCP Unitdata message |
| UE | User Equipment |
| UL | Uplink |
| UMTS | Universal Mobile Telecommunication System |
| USIM | Universal Subscriber Identity Module |
| UTRAN | Universal Terrestrial Radio Access Network |
| VASP | Value Added Service Provider |
| VHE | Virtual Home Environment |
| WCDMA | Wideband Code Division Multiple Access |

Further GSM related abbreviations are given in GSM 01.04. Further UMTS related abbreviations are given in UMTS TS 21.905 [3].

# 5 Main concepts

A general description of location services and service requirements are given in the specification TS 22.071 [4]. The positioning of the MS is a service provided by the Access Network. In particular, all Access Networks (e.g. UTRAN, GERAN), that facilitate determination of the locations of User Equipments, shall be able to exchange location information with the core network as defined in the present document (when connected to a Core Network).

By making use of the radio signals the capability to determine the (geographic) location of the user equipment (UE) or mobile station (MS) shall be provided. The location information may be requested by and reported to a client (application) associated with the MS, or by a client within or attached to the Core Network. The location information may also be utilised internally in the system; for example, for location assisted handover or to support other features such as home location billing. The position information shall be reported in standard, i.e. geographical co-ordinates, together with the time-of-day and the estimated errors (uncertainty) of the location of the MS according to specification TS 23.032 [11].

It shall be possible for the majority of the MS (active or idle) within a network to use the feature without compromising the radio transmission or signalling capabilities of the GSM/UMTS networks.

The uncertainty of the location measurement shall be network design (implementation) dependent at the choice of the network operator, this is further described in TS 25.305 3.1 and TS 43.059 [16].

There are many different possible uses for the location information. The positioning feature may be used internally by the GSM/UMTS network (or attached networks), by value-added network services, by the MS itself or through the network, and by "third party" services. The positioning feature may also be used by an emergency service (which may be mandated or "value-added"), but the position service is not exclusively for emergencies.

# 5.1 Assumptions

As a basis for the further development work on LCS in GSM and UMTS the following assumptions apply:

- Positioning methods are Access Network specific, although commonalties should be encouraged between Access Networks.

- Commercial location services are only applicable for an MS with a valid SIM or USIM.

- The provision of the location services in the Access Network is optional through support of the specified method(s).

- The provision of location services is optional in MSC and SGSN.

- LCS is applicable to any target MS whether or not the MS supports LCS, but with restrictions on choice of positioning method or notification of a location request to the MS user when LCS or individual positioning methods, respectively, are not supported by the MS.

- LCS shall be applicable for both circuit switched and packet switched services.

- The location information may be used for internal system operations to improve system performance.

- It shall be possible to accommodate future techniques of measurement and processing to take advantage of advancing technology so as to meet new service requirements.

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- It may be necessary to support LCS signaling between separate access networks via the core network. The Iur interface should be used if available.

# 5.2 Location Services Categories

Generally there are four categories of usage of the location service. These are the Commercial LCS, the Internal LCS, the Emergency LCS and the Lawful Intercept LCS. The definition of these services and their categories is outside the scope of the present document.

- The **Commercial LCS** (or **Value Added Services**) will typically be associated with an application that provides a value-added service through knowledge of the MS location to the subscriber of the service. This may be, for example, a directory of restaurants in the local area of the MS, together with directions for reaching them from the current MS location.

- The **Internal LCS** will typically be developed to make use of the location information of the MS for Access Network internal operations. This may include; for example, location assisted handover and traffic and coverage measurement. This may also include support certain O&M related tasks, supplementary services, IN related services and GSM bearer services and teleservices.

- The **Emergency LCS** will typically be part of a service provided to assist subscribers who place emergency calls. In this service, the location of the MS caller is provided to the emergency service provider to assist them in their response. This service may be mandatory in some jurisdictions. In the United States, for example, this service is mandated for all mobile voice subscribers.

- The **Lawful Intercept LCS** will use the location information to support various legally required or sanctioned services.

## 5.3 Positioning methods

The LCS feature utilises one or more positioning methods in order to determine the location of user equipment (MS). Determining the position of a MS involves two main steps:

- Radio signal measurements; and

- Position estimate computation based on the measurements.

The positioning methods for UTRAN are further described in TS 25.305 3.1.

### 5.3.1 Standard LCS Methods in UTRAN

The specification 25.305 UTRAN Stage 2 specifies the locating methods to be supported:

- Cell coverage based positioning method.

- OTDOA positioning method;

- GPS based positioning methods

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For more details on these positioning methods, refer to TS 25.305 [1].

### 5.3.2 Standard LCS Methods in GERAN

The specification TS 43.059 GERAN LCS Stage 2 [16] specificies the locating methods to be supported in GERAN:

- Cell coverage based positioning method.

- Enhanced Observed Time Difference (E-OTD) positioning method;

- GPS based positioning methods

# 6 General LCS architecture

## 6.1 LCS access interfaces and reference points

There is one reference point between the LCS server and LCS client called Le, see Figure 5.1. Le is described in TS 22.071 [4], 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 interface called Lg that connects two independent LCS networks (different PLMNs) for message exchange.
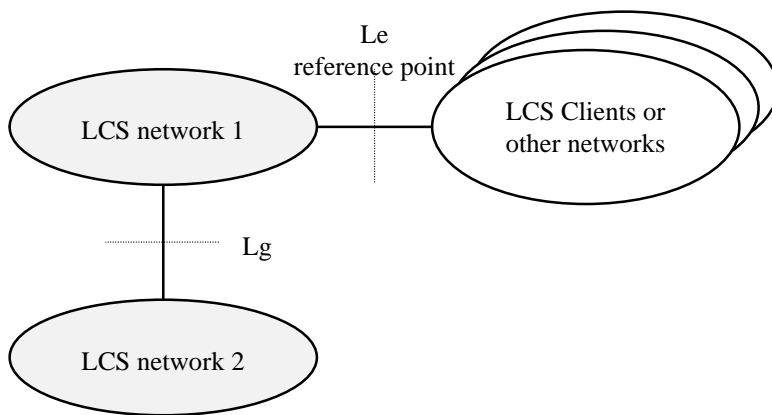
**Figure 5.1: LCS Access Interfaces and Reference Points**

# 6.2 LCS Functional diagram, high level functions

TS 22.071 [4] describes LCS services from the LCS client point of view. In the present document, a more detailed description of LCS is given. The LCS functional diagram shown in Figure 5.2 depicts the interaction of the LCS client and the LCS server within the PLMN. The PLMN uses the various LCS components within the LCS server to provide the target MS Location Information to the LCS client.
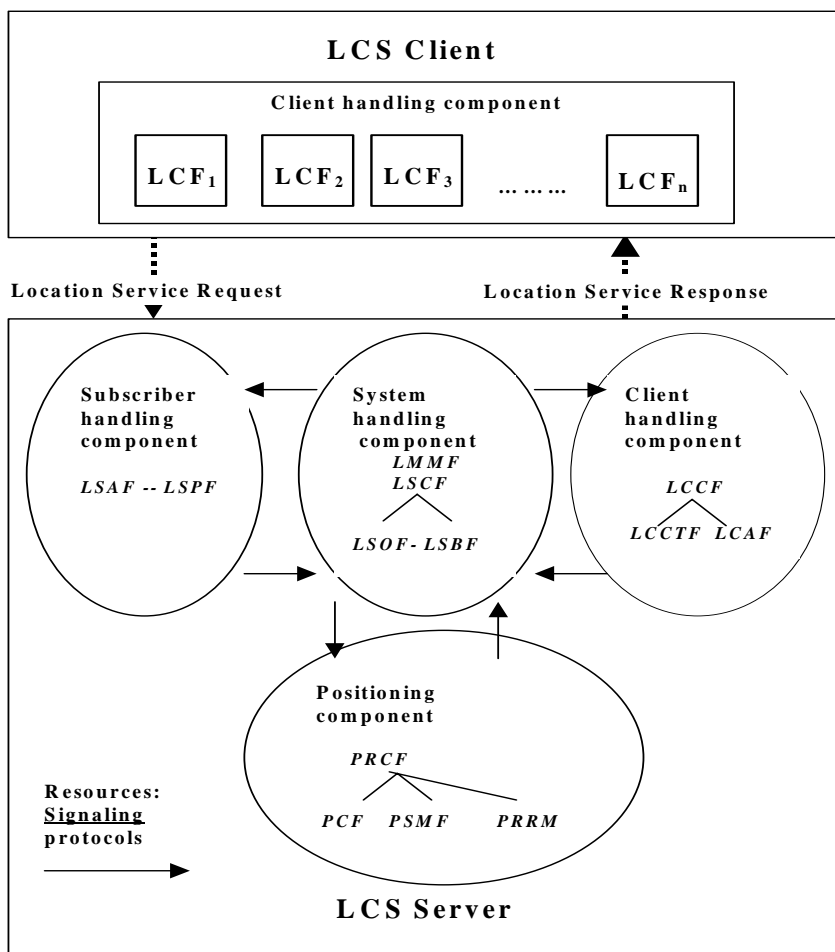


**Figure 5.2: LCS capability server Functional Diagram**

The following list gives the logical functional entities for the LCS. Two main functional groupings are defined which encompass a number of smaller functions.

The LCS Functional entities are grouped as follows:

- The LCS Client functional group.

- The LCS Server functional group consists of functions in the UMTS PLMN supporting LCS:

  - Client handling component;

  - System handling component;

  - Subscriber handling Component;

  - Positioning component.

The functions of the LCS Client and the LCS Server in the PLMN are described in more detail in this subclause.

The allocation of LCS functions to network elements is specified in clause 6.

# 6.3 LCS Client functional group

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 the present document.

## 6.3.1 External 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.

[Editor's note: this is only possible if the location request originates in the core network]

# 6.4 [NOTE: This is defined in TS 25.305 3.1]LCS Server functional group

The LCS server functional group consists of the functions that are needed for GSM and UMTS to support Location Services.

## 6.4.1 Client handling component

### 6.4.1.1 Location Client Control Function (LCCF)

The Location Client Control Function (LCCF) manages the external interface towards LCF. The LCCF identifies the LCS client 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 or SGSN. 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 Co-ordinate Transformation Function (LCCTF) to perform a transformation to local co-ordinates. It also generates charging and billing related data for LCS via the Location System Billing Function (LSBF).

### 6.4.1.2   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.

#### 6.4.1.2.1  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.

#### 6.4.1.2.2  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); (see note)

- 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;

    NOTE:    LIR = Location Immediate Request; and LDR = Location Deferred Request.

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.

### 6.4.1.3   Location Client Co-ordinate Transformation Function (LCCTF)

The Location Client Co-ordinate 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.

## 6.4.2 System handling component

### 6.4.2.1 Location System Control Function(LSCF)

The Location System Control Function (LSCF) is responsible for co-ordinating location requests. This function manages call-related and non-call-related positioning requests of LCS and allocates network resources for handling them. The LSCF retrieves MS classmark information for the purpose of determining a positioning method. [NOTE: UMTS UE capabilities to be added here.] The LSCF performs call setup if required as part of a LCS e.g., putting the ME on dedicated radio resources. It also caters for co-ordinating 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.

The U-LSCF for UTRAN is further described in TS 25.305 3.1, LSCF for GERAN is described in TS 43.059 [16].

### 6.4.2.2 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.

### 6.4.2.3 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 LCS.

An LSOF may be associated with each entity.

[Editor's note: This is being studied in GSM. FFS in UMTS. Internal LCF may be part of O&M functions.]

### 6.4.2.4 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 OTDOA or assisted GPS positioning methods.

## 6.4.3 Subscriber handling Component

### 6.4.3.1 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 station (MS with SIM/USIM). Specifically, this function validates that a LCS can be applied to a given subscriber. In case LCF is in the MS then LSAF verifies that the MS subscriber has subscribed to the requested LCS service.

### 6.4.3.2 Location Subscriber Privacy Function (LSPF)

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

## 6.4.4 Positioning components

The positioning components Positioning Radio Co-ordination Function (PRCF), Positioning Calculation Function (PCF), Positioning Signal Measurement Function (PSMF) and Positioning Radio Resource Management (PRRM) are described in documents specific to each Access Network type.

For location services the Access Network shall send the result of the positioning to the core network in geographical co-ordinates as defined in TS 23.032. The Access Network shall map the cell(s) the Target MS is associated with into geographical co-ordinates, but this mapping is not standardized.

These entities are defined in TS 25.305 [1] for UTRAN and in TS 43.059 [16] for GERAN.

# 6.5 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.

## 6.5.1 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 attributes for the information exchange between the LCS Client and the LCS Server have not been standardized for GSM. This information exchange may be standardized in later releases.

The following attributes are identified for Location Service Request information flow:

- Target MS;

- LCS identity;

- State (idle, dedicated);

- Event (applicable to LDR requests only);

- Requested Quality of Service information;

- Local coordinate reference system;

- Geographical area, [should be checked with the meaning of "Geographical area" in TS 03.71 [5].]

## 6.5.2 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.

The following attributes are identified for the Location Service Response information flow:

- Location indication of MS in geographical coordinates;

- Location of MS as an ellipsoid with axes and direction of all axis;

- Estimated achieved QoS;

- Indication when MS enters or leaves the Geographical area.

Some information attributes may be common and repeated for the location service request and location service response, such as Target MS, LCS identity, State, Event, Local co-ordinate system, geographical area.

# 7 LCS Architecture

Figure 6.1 shows the general arrangement of the Location Service feature in GSM and UMTS. This illustrates, generally, the relation of LCS Clients and servers in the core network with the GERAN and UTRAN Access Networks. The LCS entities within the Access Network communicate with the Core Network (CN) across the A, Gb and Iu interfaces. Communication among the Access Network LCS entities makes use of the messaging and signalling capabilities of the Access Network.

As part of their service or operation, the LCS Clients may request the location information of MS. There may be more than one LCS client. These may be associated with the GSM/UMTS networks or the Access Networks operated as part of a MS application or accessed by the MS through its access to an application (e.g. through the Internet).

The clients make their requests to a LCS Server. There may be more than one LCS Server. The client must be authenticated and the resources of the network must be co-ordinated including the MS and the calculation functions, to estimate the location of the MS and result returned to the client. As part of this process, information from other systems (other Access Networks) can be used. As part of the location information returned to the client, an estimate of the accuracy of the estimate and the time-of-day the measurement was made may be provided.
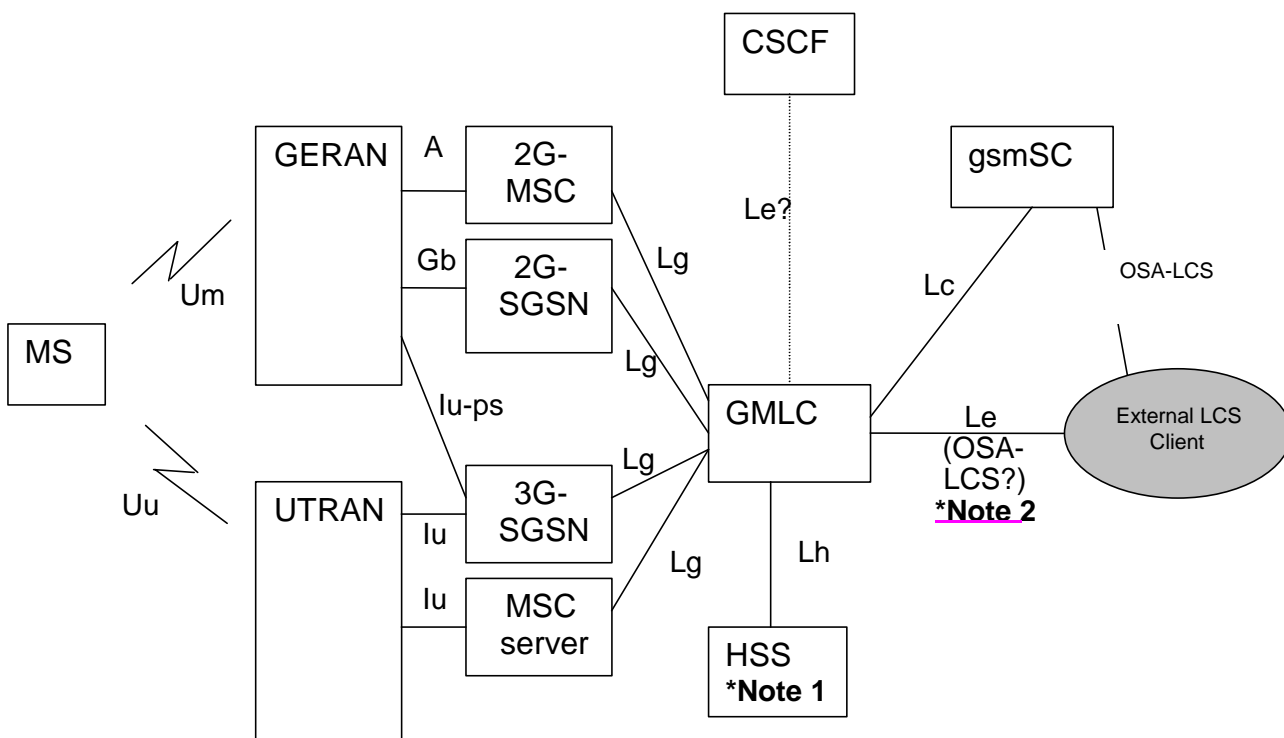


*Note 1: HSS includes both 2G-HLR and 3G-HLR functionality. LCS should be included in the overall network architecture in TS 23.002.

*Note 2: The Le interface is FFS. S1 agreed that LCS shall support OSA-API.

**Figure 6.1: General arrangement of LCS**

## 7.1 Schematic functional description of LCS operations

The allocation of LCS functional blocks to the Client, LCS server, Core Network, Access Network and MS is based on the schematic functional description below. The detailed functions and interactions are specified later in the present

document and in TS 25.305 3.1 for UTRAN, in TS 43.059 [16] for GERAN and in corresponding Stage 3 specifications.

The operation begins with a LCS Client requesting location information for a MS from the LCS server. The LCS server will pass the request to the LCS functional entities in the core network. The LCS functional entities in the core network shall then:

- verify that the LCS Client is authorized to request the location of the MS or subscriber;

- verify that LCS is supported by the MS;

- establish whether it is allowed to locate the MS or subscriber, for privacy or other reasons;

- establish which network element in the Access Network should receive the Location request;

- request the Access Network (via the A, Gb or Iu interface) to provide location information for an identified MS, with indicated QoS;

- receive information about the location of the MS from the Access Network and forward it to the Client;

- send appropriate accounting information to an accounting function.

The Access Network LCS functional entities shall determine the position of the target MS according to TS 25.305 3.1 for UTRAN and TS 43.059 [16] for GERAN:

# 7.2    Allocation of LCS functions to network elements

Table 6.1 shows a summary of the Functional Groups and Functional Blocks for Location services. Table 6.2 and Figure 6.2 show the generic configuration for LCS and the distribution of LCS functional blocks to network elements. Different positioning methods, including network-based, mobile-based, mobile-assisted and network-assisted positioning methods may be used. With this configuration both the network and the mobiles are able to measure the timing of signals and compute the mobile's location estimate. Depending on the applied positioning method it is possible to utilise the corresponding configuration containing all needed entities. For instance, if network-based positioning is applied, the entities that are involved in measuring the mobile's signal and calculating its location estimate are allocated to the network elements of the access stratum. On the other hand, in case mobile-based or network-assisted methods are used these entities should be allocated to the MS.

LCS is logically implemented on the network structure through the addition of one network node, the Mobile Location Center (MLC). It is necessary to name a number of new interfaces. The LCS generic architecture can be combined to produce LCS architecture variants.

**Table 6.1: Summary of Functional Groups and Functional Blocks for Location services**

| Funct.Group | Functional component | Full name of Functional Block | Abbrev. |
|---|---|---|---|
| **Loc. Client** | Location Client Component | (External) Location Client Function | LCF |
| | | Internal Location Client Function | LCF -internal |
| | | | |
| | | | |
| **LCS Server in PLMN** | Client handling component | Location Client Control Function | LCCF |
| | | Location Client Authorization Function | LCAF |
| | | | |
| | | | |
| | System handling component | | |
| | | Location System Control Function | LSCF |
| | | | |
| | | Location System Billing Function | LSBF |
| | | Location System Operations Function | LSOF |
| | | | |
| | Subscr. handling component | Location Subscriber Authorization Function | LSAF |
| | | Location Subscriber Privacy function | LSPF |

|  | Positioning component | Positioning Radio Control Function | PRCF |
|---|---|---|---|
|  |  | Positioning Calculation Function | PCF |
|  |  | Positioning Signal Measurement Function | PSMF |
|  |  | Positioning Radio Resource Management | PRRM |

Table 6.2 and Figure 6.2 illustrate the allocation of functional entities in the reference configuration of LCS. It is assumed that the CS and PS have either their own independent mobility management or use the joint mobility management through the optional Gs interface.

It is also seen that LCS may take benefit of the Iur interface between RNCs, when uplink radio information and measurement results are collected.

The functional model presented in the figure includes functional entities for both CS and PS related LCS. In addition, it consists of all the entities needed for different positioning methods, i.e. network based, mobile based, mobile assisted, and network assisted positioning, exploiting either uplink or downlink measurements. It is noted that the MS may use e.g. the GPS positioning mechanism, but still demand e.g. auxiliary measurements from the serving network. RAN specific functional entities are specified in TS 25.305 3.1 for UTRAN and in TS 43.059 [16] for GERAN

**Table 6.2: Allocation of LCS functional entities to network elements**

|  | MS | RAN | GMLC | SGSN | MSC/MSC Server | HLR/HSS | Client |
|---|---|---|---|---|---|---|---|
| **Location client functions** | | | | | | | |
| **LCF** | X |  |  | X | X |  | X |
| ***LCF Internal*** | Ffs | X |  |  |  |  |  |
| **Client handling functions** | | | | | | | |
| **LCCTF** |  |  | X |  |  |  |  |
| **LCCF** |  |  | X |  |  |  |  |
| **LCAF** |  |  | X |  |  |  |  |
| **System handling functions** | | | | | | | |
|  |  |  |  |  |  |  |  |
| **LSCF** |  | X |  | X | X |  |  |
|  |  |  |  |  |  |  |  |
| **LSBF** |  |  | X | X | X |  |  |
| **LSOF** | X | X | X | X | X |  |  |
| **Subscriber handling functions** | | | | | | | |
| **LSAF** |  |  |  | X | X |  |  |
| **LSPF** |  |  |  | X | X | X |  |
| **Positioning functions** | | | | | | | |
| **PRCF** |  | X |  |  |  |  |  |
| **PCF** | X | X |  |  |  |  |  |
| **PSMF** | X | X |  |  |  |  |  |
| **PRRM** |  | X |  |  |  |  |  |
|  | **MS** | **RAN** | **GMLC** | **SGSN** | **MSC/MSC Server** |  | **Client** |
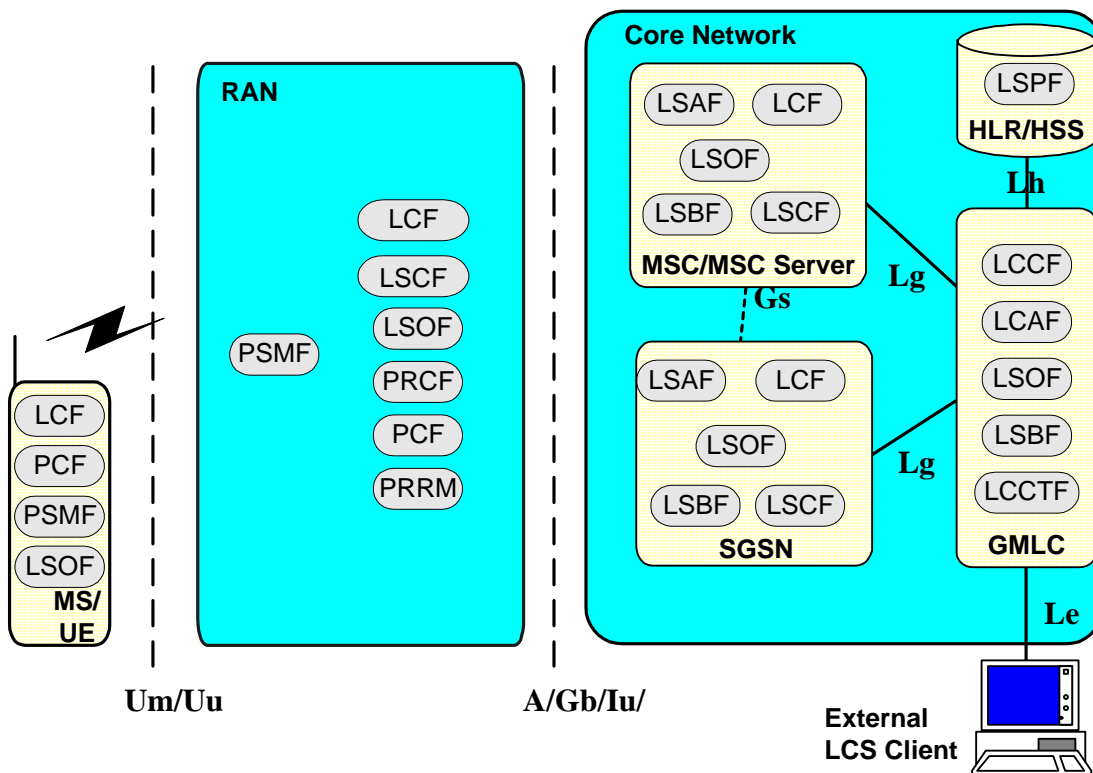
**Figure 6.2: Generic LCS Logical Architecture**

# 7.3 Functional description of LCS per network element

## 7.3.1 Access Network

The Access Network is involved in the handling of various positioning procedures.

The LCS specific functionalities of the radio access network elements are specified in TS 25.305 3.1 for UTRAN and TS 43.059 [16] for GERAN.

## 7.3.2 LCS Clients and LCS applications

There are two classes of LCS Application – Internal applications and External applications. Internal applications represent entities internal to the GSM/UMTS that make use of location information for the (improved) operation of the network. External applications represent entities (such as Commercial or Emergency services) that make use of location information for operations external to the mobile communications network. The LCS Applications interface to the LCS entities through their Location Client functions (LCF).

The LCS Client and LCS applications are outside the scope of the present document.

## 7.3.3 Gateway Mobile Location Center, 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 or HSS via the Lh interface. After performing registration authorization, it sends positioning requests to either VMSC, SGSN or MSC Server and receives final location estimates from the corresponding entity via Lg interface.

## 7.3.4    LCS support in the MS

The MS may be involved in the various positioning procedures. Specific MS involvement is specified in each of the positioning procedures specified in TS 25.305 3.1 for UTRAN and  TS 43.059 [16] for GERAN.

The MS interacts with the measurement co-ordination functions to transmit the needed signals for uplink based LCS measurements and to make measurements of downlink signals. The measurements to be made will be determined by the chosen location method.

The MS may also contain LCS applications, or access a LCS application through communication with a network accessed by the MS or an application residing in the MS. This application may include the needed measurement and calculation functions to determine the MS's location with or without assistance of the GSM/UMTS LCS entities.

The MS may also, for example, contain an independent location function (e.g. Global Satellite Positioning Service GPS) and thus be able to report its location, independent of the RAN transmissions. The MS with an independent location function may also make use of information broadcast by the RAN that assists the function.

## 7.3.5    MSC/VLR

The MSC/VLR contains functionality responsible for MS subscription authorization and managing call-related and non-call related positioning requests of LCS. The MSC is accessible to the GMLC via the Lg interface. The LCS functions of MSC are related to charging and billing, LCS co-ordination, location request, authorization and operation of the LCS services.

## 7.3.6 MSC Server

The MSC Server handles the same functionality as the MSC/VLR including charging and billing, LCS co-ordination, location request, authorization and operation of the LCS services. The MSC Server is accessible to the GMLC via the Lg interface.

## 7.3.7    SGSN

The  SGSN contains functionality responsible for MS subscription authorization and managing positioning requests of LCS. The SGSN is accessible to the GMLC via the Lg interface. The LCS functions of SGSN are related to charging and billing, LCS co-ordination, location request, authorization and operation of the LCS services.

## 7.3.8    Home Location Register, HLR

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

## 7.3.9 HSS

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

## 7.3.10   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 TS 23.078 and TS 29.002, respectively.

## 7.3.11   CSCF

The role of CSCF is probably limited to handling of location information e.g. related to emergency calls. This is FFS.

## 7.4    Addressing the target MS for LCS purposes

It shall be possible to address and indicate the target MS using MSISDN. It may be possible in certain cases to address the target MS using IP address e.g. when a static IP address has been allocated for the MS. This is FFS.

# 8 Signaling and Interfaces

## 8.1 LCS signaling between Access and Core Networks

The core network sends location requests to the access network, which then sends the corresponding responses back to the core network.

Communication between access and core networks is accomplished through Iu interface in UMTS whereas A, Gb and Iu-ps interfaces are used for the purpose in GSM. (See TS 25.305 [1] and TS 43.059 [16].

### 8.1.1 Core network Location Request

The core network request for a location estimate of a target MS shall contain sufficient information to enable location of the Target MS according to the required QoS using any positioning method supported by the PLMN and, where necessary, MS. For location services the core network may request the geographical co-ordinates of the Target MS.

In UMTS the core network may also request in which Service Area the Target MS is located. The Service Area information may be used for routing of corresponding Emergency calls, or for CAMEL services. (The MSC Server or SGSN shall not send the Service Area Identity to GMLC).

In GSM this corresponds to the usage of Cell ID in the core network.

It should be noted that the Service Area concept is different from the Localized Service Area concept used for SoLSA services.

When the location of a Target MS in Idle Mode is requested, the core network shall determine which RAN entity is associated with the Target MS.

### 8.1.2 Location Report

The access network reports the location of the Target MS to the core network entities. The location report may contain the following information as defined in the corresponding location request:

- the geographical co-ordinates of the Target MS;

- the service area in which the Target MS is located;

- achieved quality level of the location estimate;

## 8.2 Um and Uu Interfaces

NOTE: This chapter may change depending on whether air interface LMU will exists in the logical architecture or not.

The Um and Uu interfaces are used to communicate among the LCS entities associated with the BSC and RNC, the MS and the stand-alone Location Measurement Units (LMU). The Um and Uuinterfaces are also used to communicate between the LCS entities in the core network and the MS.

The Um/Uu interfaces may pass measurement requests and results to and from MS or the stand-alone LMU.

The Um/Uu interfaces may also pass location requests from internal or external LCS Clients (Applications) at the MS. Note that these requests may require the services of the LCS entities associated with the core network to authenticate clients and subscriber subscriptions to aspects of the LCS.

The Um/Uu interfaces may also be used for broadcast of information that may be used by the MS or stand-alone LMU for their LCS operations. This may, for example, include timing information about nearby Node-B/BTS transmissions that may assist the MS or LMU in making their measurements. In UTRAN code information may be included.

The Um and Uu interfaces may also pass messages relating to changes or reporting of the data associated with the Location System Operations Function (LSOF) in the MS or the remote LMU.

UTRAN Stage 2 specification TS 25.305 [1] specifies LCS signaling over the Uu interface and GERAN Stage 2 specification TS 43.059 [16] over the Um interface correspondingly.

Message segmentation is specified in GERAN LCS Stage 2, TS 43.059 [16].

## 8.3 MAP Interfaces

The following interfaces are based on MAP in LCS.

· Lh interface: interface between GMLC and HLR . This interface is used by the GMLC to request the address of the visited MSC or SGSN for a particular target MS whose location has been requested.
· Lg interface:interface between GMLC  MSC and GMLC – SGSN. This interface is used by the GMLC to convey a location request to the MSC or SGSN currently serving a particular target MS whose location was requested. The interface is used by the MSC or SGSN to return location results to the GMLC.
· Lc: interface between GMLC and gsmSCF, CAMEL. This interface is used to get location information for CAMEL based services.


The following MAP services are defined for LCS:

- MAP-SEND-ROUTING-INFO-FOR-LCS Service.

This service is used between the GMLC and the HLR/HSS to retrieve the routing information needed for routing a location service request to the serving VMSC , SGSN. The service may be used in GMLC - HSS interface to retrieve routing information in order to route the location service request to the correct VMSC, SGSN and MSC Server.

- MAP-PROVIDE-SUBSCRIBER-LOCATION Service.

This service is used by a GMLC to request the location of a target MS from the visited MSC, SGSN or MSC Server at any time.

- MAP-SUBSCRIBER-LOCATION-REPORT Service.

This service is used by a VMSC, SGSN or MSC Server to provide the location of a target MS to a GMLC when a request for location is either implicitly administered or made at some earlier time.

The MAP Subscriber Location Report could also be used to send information about location of the Target MS (for MO-LR) to an external client.

# 9 General network location procedures

## 9.1 State description for GMLC

### 9.1.1 GMLC states

#### 9.1.1.1 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.
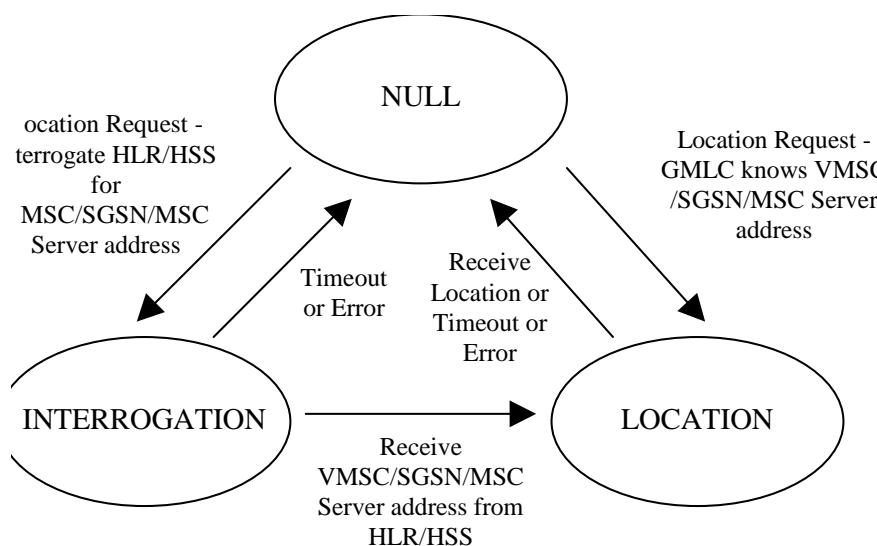
### 9.1.1.2 INTERROGATION State

In this state, the GMLC has sent an interrogation to the home HLR/HSS of the MS to be located and is awaiting a response giving one or several of the following addresses:the VMSC, MSC Server, SGSN address and IMSI for this MS.

### 9.1.1.3 LOCATION State

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

## 9.1.2 State functionality

### 9.1.2.1 State Transitions

**Figure 8.1: State Transitions in the GMLC**

**Moving from NULL to INTERROGATION state:**

> If the GMLC does not know any of the following addresses:VMSC, MSC Server, SGSN address or 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/HSS for the VMSC/ MSC Server/ SGSN address and IMSI.

**Moving from NULL to LOCATION state:**

If the GMLC already knows one of the following addresses: VMSC, MSC Server, SGSN or 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 either the VMSC, MSC Server or SGSN.

[Note: it is for further study how GMLC selects if it shall send the location request to VMSC, MSC server and/or SGSN in different cases. This should be specified in the signaling procedures.]

**Moving from INTERROGATION to LOCATION state:**

After the GMLC, in the INTERROGATION state, receives one or several of the addresses VMSC, MSC Server, SGSN, and IMSI from the home HLR/HSS, it enters the LOCATION state and sends a location request to either the VMSC, MSC Server or SGSN of the MS being located.

**Moving from LOCATION to NULL state:**

After the GMLC receives a location estimate response from the VMSC, MSC Server or SGSN, it forwards the location estimate to the requesting LCS client and re-enters the NULL state.

### 9.1.2.2   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/HSS. If the timer expires before an interrogation response is received, the GMLC indicates a location failure to the LCS client and re-enters the NULL state.

### 9.1.2.3   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/ MSC Server /SGSN. If the timer expires before a response is received, the GMLC indicates a location failure to the LCS client and re-enters the NULL state.

## 9.2   State description for VMSC and MSC Server

### 9.2.1   VMSC and MSC Server States

NOTE: Periodic location service may need to be covered in the state descriptions.

#### 9.2.1.1   LCS IDLE State

In this state, the VMSC/MSC Server location service is inactive for a particular MS. The MS may be known in the VMSC/MSC Server (except for a USIM less or SIM less Emergency call or where the MS information has been cancelled or lost in the VMSC/MSC Server), but there may not be an active Mobility Management to the MS.

#### 9.2.1.2   LOCATION State

In this state, the VMSC/MSC Server is awaiting a response from RAN after requesting the location for a particular MS..

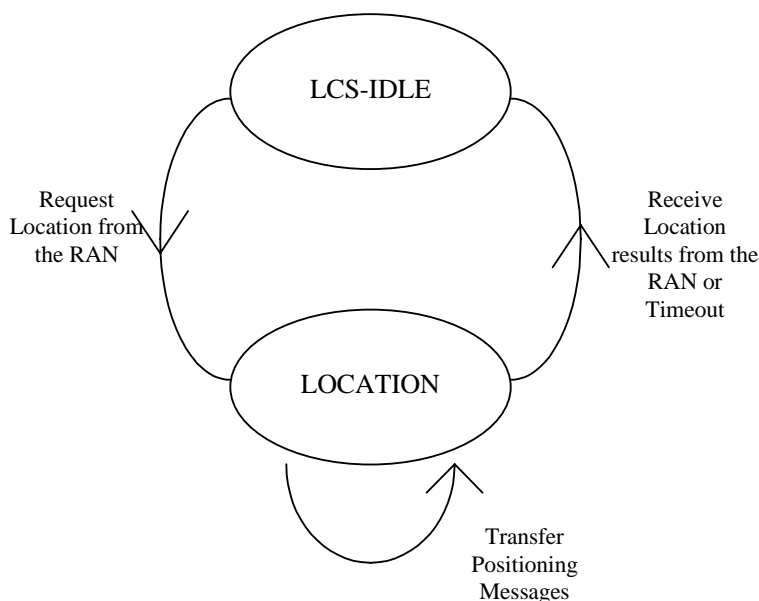### 9.2.2   State Functionality

#### 9.2.2.1   State Transitions



**Figure 8.2: State Transitions in the VMSC/MSC Server**

**Moving from LCS 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 RAN of the MS to be located: the VMSC/MSC Server then enters the LOCATION state. Before entering this state, the VMSC/MSC Server must have setup a Mobility Management connection to the MS if none was previously active. The mobile is paged and authenticated before positioning.

**Moving from LOCATION to LCS IDLE state:**

After the return of a location estimate result from RAN, the VMSC/MSC Server shall re-enter IDLE state.

### 9.2.2.2   LOCATION Timer Function

TheVMSC/MSC Server runs a timer while in the LOCATION state to limit the amount of time waiting for a location response from the RAN. If the timer expires before such information is received, the VMSC/MSC Server indicates a location failure to the original requesting entity and re-enters IDLE state.

# 9.3     LCS State description for SGSN

## 9.3.1   SGSN States

### 9.3.1.1   LCS IDLE State

In this state, the SGSN location service is inactive for a particular MS. The MS is known in the SGSN except in case where the MS data has been cancelled or lost in the SGSN. There is not an active Mobility Management to the MS.

### 9.3.1.2   LOCATION State

In this state, the SGSN is awaiting a response from the RAN after requesting the location for a particular MS. In this state, a Mobility Management connection to the target MS will be active.

## 9.3.2   State Functionality

### 9.3.2.1   State Transitions
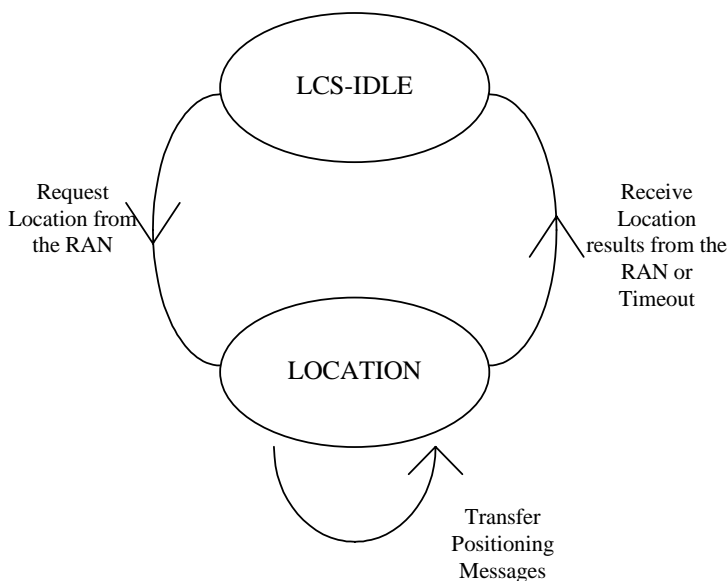


**Figure 8.3: State Transitions in the SGSN**

**Moving from LCS-IDLE to LOCATION state:**

After a request has been received to locate a particular MS and the MS subscription options have been verified to allow this, the SGSN sends a location request to the RAN. The SGSN then enters the LOCATION state. Before entering this state, the SGSN must have setup a Mobility Management connection to the MS if none was previously active. The mobile is paged and authenticated before positioning.

**Moving from LOCATION to LCS IDLE state:**

After the return of a location estimate result from RAN, or if the Location Timer described below expires, the SGSN shall re-enter IDLE state.

### 9.3.2.2   LOCATION Timer Function

The SGSN runs a timer while in the LOCATION state to limit the amount of time waiting for a location response from the RAN. If the timer expires before such information is received, the SGSN indicates a location failure to the original requesting entity and re-enters IDLE state.

## 9.4    Iu Signaling Connection

In case the Iu interface is used for communication between core network and RAN, then before SGSN/MSC Server can request location information of a Target MS from RAN, an Iu Signaling Connection must have been established between SGSN/MSC Server and RAN. The SGSN/MSC Server sends a  Location Request message to RANRAN, which determines the location of the target MS related to this Iu Signalling Connection and sends a Location Report to SGSN/MSC Server over the same Iu Signalling Connection.

NOTE: Similar clarification is needed for A and Gb interface based cases.

# 10     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.

## 10.1    Mobile Terminating Location Request

### 10.1.1   Circuit Switched Mobile Terminating Location Request (CS-MT-LR)

Figure 9.1 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 NOTE: The following text shall be alligned to support CS-MT-LR through the new network elements HSS and MSC Server, the impacts of A interface between core network and RAN shall be reflected in the text as well.]
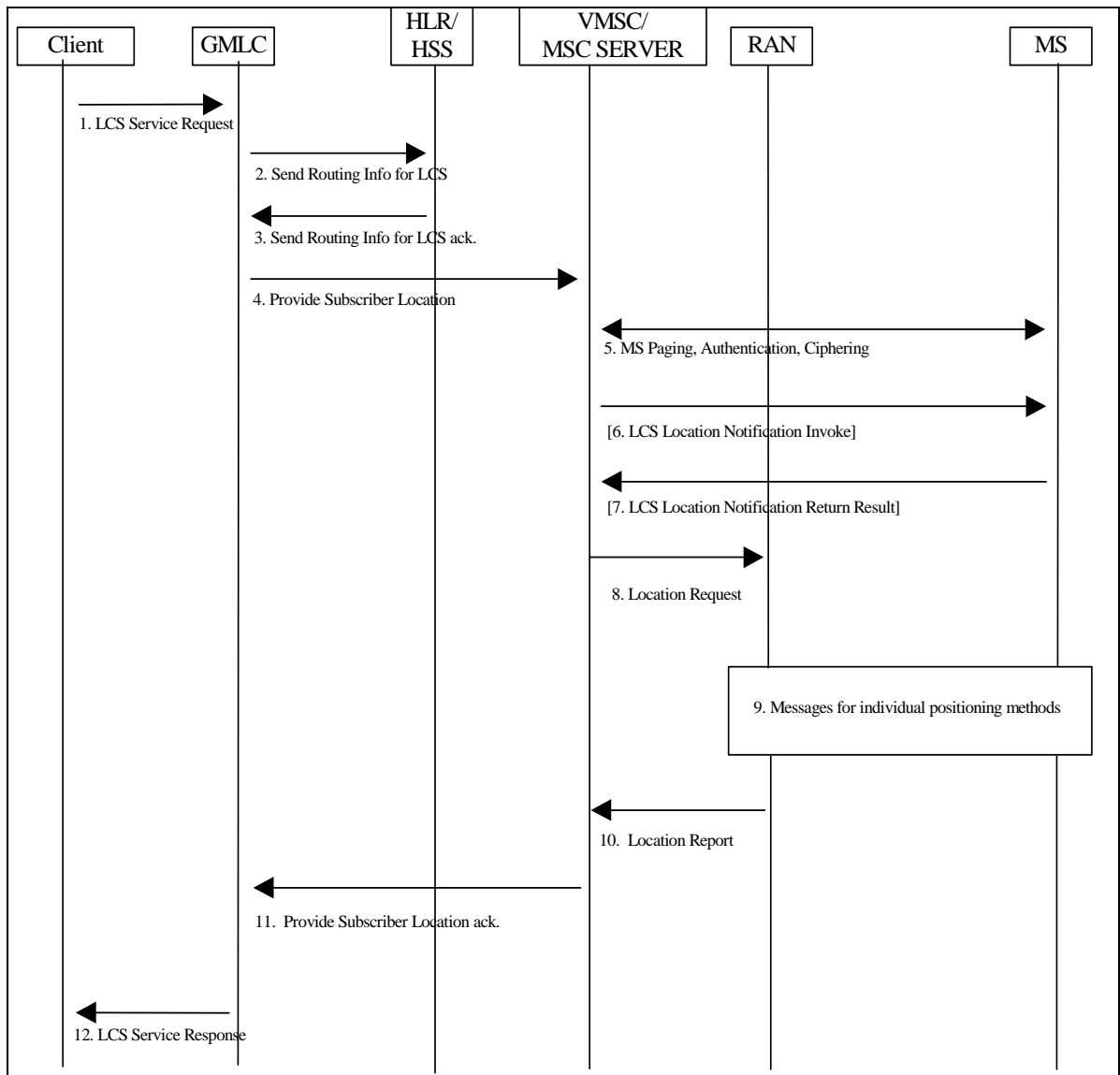


**Figure 9.1: General Network Positioning for a MT-LR**

## 10.1.1.1  Location 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 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 calling party SCCP address of the GMLC corresponds to a known UMTS 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 PROVIDE_ SUBSCRIBER _LOCATION message to the MSC indicated by the HLR. This message carries the type of location information requested (e.g. current location), the MS subscriber's IMSI, LCS QoS information (e.g. accuracy, response time) 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. 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 Core Network performs paging, authentication and ciphering. If the target MS supports any MS based or MS assisted positioning method(s), the MS will also provide RAN and MSC with the positioning method(s) it supports via MS classmark or UE capability information. If the MS is instead in dedicated mode, the VMSC will already have MS classmark information. In GSM this is supported by controlled early classmark sending.

[GSM LCS: If the target MS has an established circuit call other than speech, the location request may be denied and an error response is then returned to the GMLC. If the location request is allowed for a non-speech circuit call, it shall be up to RAN to decide, on the basis of the applicable position methods and requested QoS, whether positioning is possible. [this is FFS]]

(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), an LCS Location Notification Invoke message is sent to the target MS indicating the type of location request (e.g. current location) and the identity of the LCS client and whether privacy verification is required. Optionally, the VMSC may after sending the LCS Location Notification Invoke message continue in parallel the location process, i.e. continue to step 8 without waiting for a LCS Location Notification Return Result message in step 7.

(7) The target MS notifies the MS user of the location request. If privacy verification was requested, the target MS indicates to the MS user whether the location request will be allowed or not allowed in the absence of a response and waits for the user to grant or withhold permission. The MS then returns an LCS Location Notification Return Result to the VMSC indicating, if privacy verification was requested, whether permission is granted or denied. Optionally, the LCS Location Notification Return Result message can be returned some time after step 6, but before step 11. 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 in the absence of a response.

(8) The MSC sends a Location Request message to RAN. This message includes the type of location information requested, the MS's location capabilities and requested QoS.

## 10.1.1.2 Positioning Measurement Establishment Procedure

(9) If the requested location information and the location accuracy within the QoS can be satisfied based on cell coverage, cell ID and, if available, RTT value, RAN may send a Location Report immediately. Otherwise, RAN determines the positioning method and instigates the particular message sequence for this method, as specified in UTRAN Stage 2[1]. If the position method returns position measurements, RAN uses them to compute a location estimate. If there has been a failure to obtain position measurements, RAN may use the current cell information and, if available, RTT value to derive an approximate location estimate. If the MS returns an already computed location estimate to SRNC using an MS based position method, RAN may verify consistency with the current cell and, if available, RTT value. If the location estimate so obtained does not satisfy the requested accuracy or the location attempt failed, e.g. due to missing data, and sufficient response time still remains, RAN may instigate a further location attempt using the same (e.g. providing more assistance data to MS) or a different position method. If a vertical location co-ordinate is requested but RAN can only obtain horizontal co-ordinates, these may be returned.

In case IPDL is used RAN may send a massage to the BS/Node B to configure the power cease period of the Node Bs involved in the positioning process. However, if the IPDL alignment is specified in lower layers e.g. layer 1 then the functional split of IPDL processing may partly included in network elements functionality.

### 10.1.1.3  Location Calculation and Release Procedure

(10) When a location estimate best satisfying the requested QoS has been obtained, RAN returns it to the MSC in a Location Report message. If a location estimate could not be obtained, RAN returns a Location Report message containing a failure cause and no location estimate.

(11) The MSC returns the location information 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 LCS Location Notification Return Result indicating that permission is granted. If a LCS Location Notification Return Result message indicating that permission is not granted is received, or there is no response, with the MS subscription profile indicating barring of location in the absence of a response, the VMSC shall return an error response to the GMLC. If RAN did not return a successful location estimate, but the privacy checks in steps 6-7 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 MSC may record billing information.

(12) 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 co-ordinates provided by the MSC into some local geographic system. The GMLC may record billing for both the LCS client and inter-network revenue charges from the MSC's network.

## 10.1.2  MT-LR and PS-MT-LR for a previously obtained location estimate

Every time the location estimate of a target MS subscriber is returned by the RAN to the VMSC, MSC Server or SGSN, the corresponding entity may store the location estimate together with a time stamp. The MSC may store this information in the subscriber's VLR record.

The time stamp is the time at which the location estimate is stored at the corresponding entity i.e. after the RAN returns the location estimate to the VMSC, MSC Server or SGSN. The time stamp indicates the "age" of the location estimate.

### 10.1.2.1  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"*.

### 10.1.2.2  Current Location

After a location attempt has successfully delivered a location estimate and its associated time stamp, the location estimate and time stamp is referred to as the *"current location"* at that point in time.

### 10.1.2.3  Last known Location

The current location estimate and its associated time stamp are stored in MSC/VLR, MSC Server or SGSN 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.

### 10.1.2.4  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). A similar status check apply for SGSN and MSC Server.

## 10.1.2.5  Failing to locate the target MS

In case of a "Detached" or "Not Reachable" target MS, the last known location and a time stamp stored at the VLR, MSC Server or SGSN, may be returned to a LCS client requesting location information if the LCS client specifically requested the current or last known location. 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, MSC Server or SGSN shall reject the location request.

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

When a request for location information is received at the VMSC, MSC Server or SGSN, the request shall indicate whether the "last known location of the target MS" should be returned in case of a "detached" or "not reachable" target MS.

If the VLR, MSC Server or SGSN 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.

### 10.1.2.5.1 Target MS is "Not Reachable"

If the target MS is marked as "attached" in the VLR, MSC Server or SGSN, the corresponding entity orders paging of the target MS. If paging fails, due to target MS being "not reachable" then the corresponding VMSC, MSC Server or SGSN shall check whether the LCS client has requested "last known location" 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, MSC Server or SGSN shall include the last known location 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, MSC Server or SGSN correspondingly.

### 10.1.2.5.2 Target MS is "Detached"

If the target MS is marked as "detached" in the VLR, MSC Server or SGSN, the corresponding entity shall check whether the LCS client has requested "last known location" 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, MSC Server or SGSN includes the "last known location" 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, MSC Server or SGSN.

### 10.1.2.5.3 Target MS is Reachable but Positioning Fails

If the target MS is reachable (e.g. paging succeeds), but the VMSC, MSC Server or SGSN is unable to obtain a current location estimate, then the  corresponding entity shall check whether the LCS client has requested "last known location".

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, MSC Server or SGSN includes the "last known location" together with the time stamp available in its response to the request for location information.

### 10.1.2.5.4 An indicator of "last known location" returned shall be marked at the CDR at VMSC, MSC Server or SGSN.Target MS is "Purged"

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

## 10.1.3   Network Induced Location Request (NI-LR)

Figure 9.2 illustrates positioning for an emergency service call.

[Editorial NOTE: The following text shall be alligned to support NI-LR through the new network elements HSS and MSC Server, the impacts of A interface between core network and RAN shall be reflected in the text as well.]
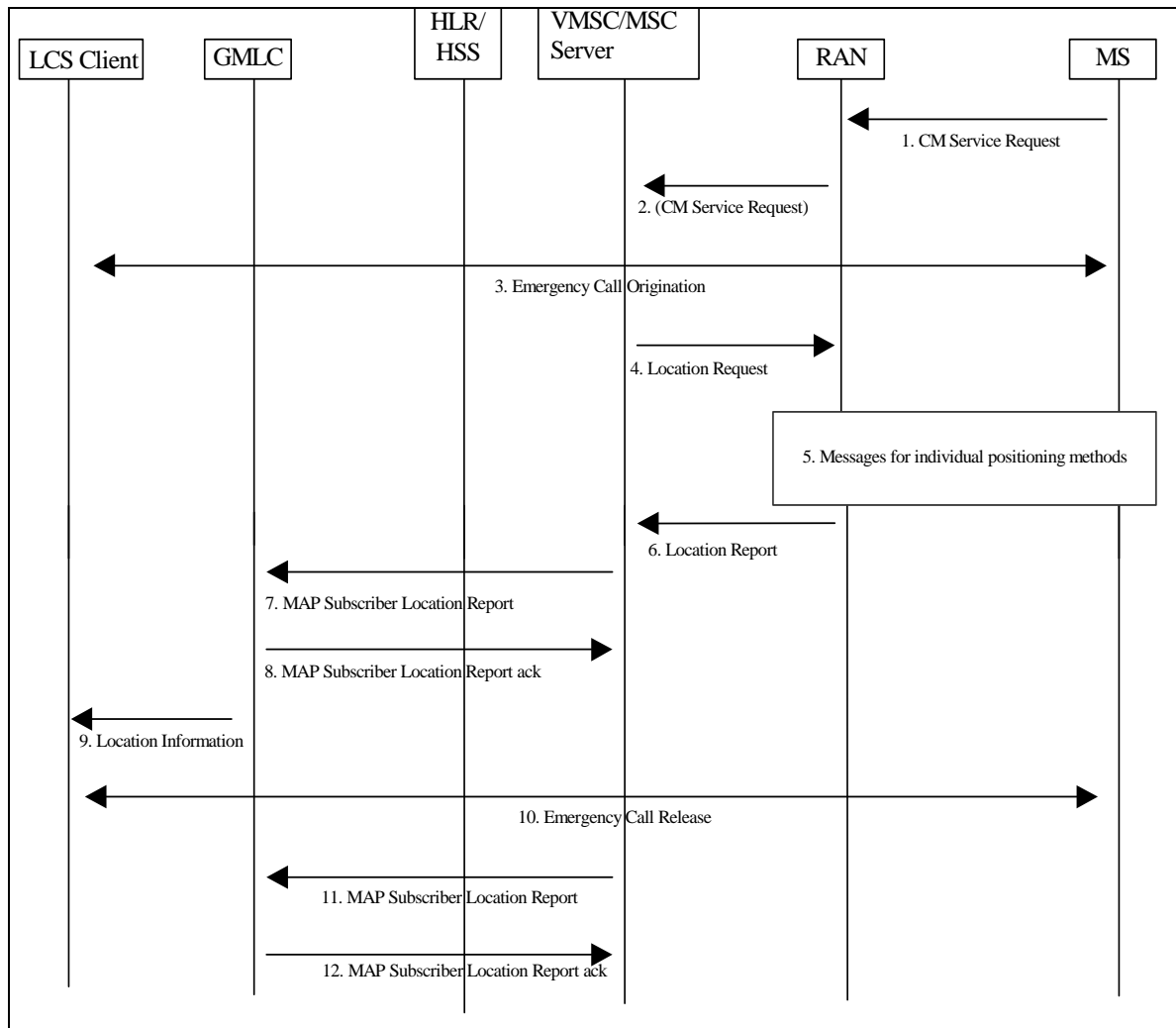


**Figure 9.2: Positioning for a NI-LR Emergency Service Call**

### 10.1.3.1  Location Preparation Procedure

(1)  An initially idle MS requests RRC setup (RACH) Service Request indicating a request for an Emergency Service call to the VMSC via RAN.

(2)  RAN shall convey the CM service request to the core network. (Before having a CM connection there must be a RRC connection.) The MS may identify itself using a TMSI, IMSI or IMEI.

(3)  The emergency call procedure is applied. The VMSC, RAN 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 and after sufficient time has been allowed to enable completion of early classmark sending to RAN and MSC where the MS supports any MS assisted or MS based positioning method(s), 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 Location Request message to RAN associated with the MS's current location area (see step 8 for a MT-LR). This message includes indication about the MS's location capabilities, and the QoS required for an emergency call.

### 10.1.3.2 Positioning Measurement Establishment Procedure

(5) The actions described under step 9 for a MT-LR are performed. If a speech compatible traffic channel is established, 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.

### 10.1.3.3 Location Calculation and Release Procedure

(6) When a location estimate best satisfying the requested QoS has been obtained, RAN returns it to the VMSC.

(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 7, 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 RAN in step 7), 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. For a North American Emergency Services call, the GMLC shall store the location information for later retrieval by the emergency services LCS client.

(9) The GMLC may optionally forward the information received in step 8 to the emergency services LCS client. For a North American emergency services call the client is expected to obtain the location information by requesting it from the GMLC.

(10) At some later time, the emergency services call is released.

(11) For a North American Emergency Services call, 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.

[Editorial NOTE: The procedure for Network Induced Location Request (NI-LR and PS-NI-LR) for a Target MS in dedicated mode should be defined in UTRAN system stage 2 [1] and GERAN Stage 2 specifications [16].]

## 10.1.4 Packet Switched Mobile Terminating Location Request (PS-MT-LR)

Figure 9.3 illustrates the general network positioning for LCS clients external to the PLMN for packet switched services. In this scenario, it is assumed that the target MS is identified using an MSISDN, PDP address or IMSI.

Note: the terminology should be more generic and aligned in the signaling descriptions for PS and CS LCS.
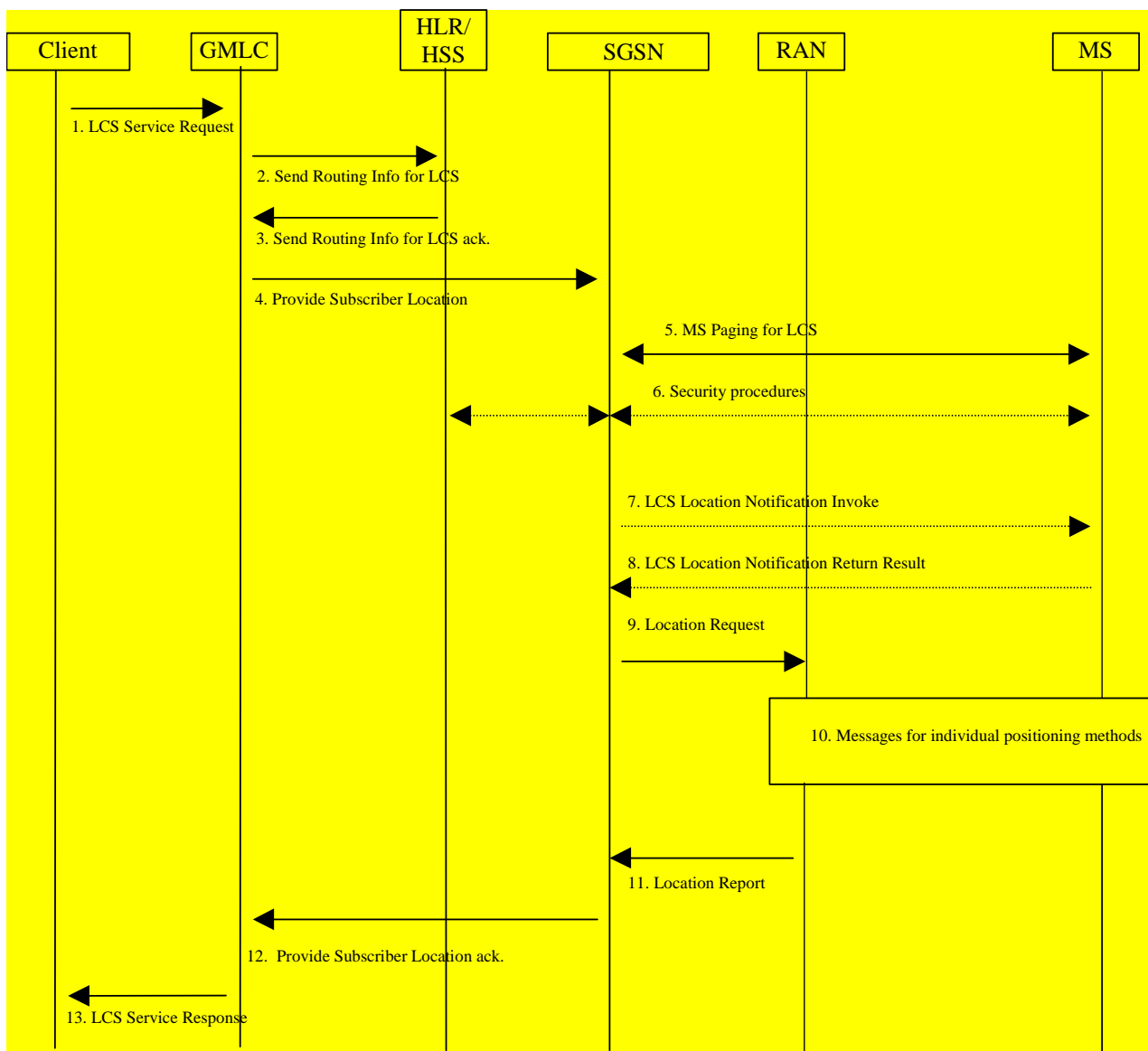
**Figure 9.3: General Network Positioning for Packet Switched MT-LR**

### 10.1.4.1  Location 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 PDP address, (NOTE: IP addressing in this context is FFS). 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. If location is required for more than one MS steps 2 to 13 above may be repeated.

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

(3)  The HLR verifies that the SCCP calling party address of the GMLC, corresponds to a known GSM/UMTS network element that is authorized to request MS location information. The HLR then returns one or several of the addresses, the current SGSN,  VMSC and/or MSC Server, conceivably prioritizing one of the addresses to be used for positioning the MS and whichever of the IMSI or MSISDN was not provided in step (2) for the particular MS.

(4) In case the GMLC receives several of the following addresses, SGSN, VMSC and/or MSC Server, it has to decide where to send the location request. In case SGSN is chosen then the GMLC sends a Provide Subscriber Location message to the SGSN indicated by the HLR/HSS. This message carries the type of location information requested (e.g. current location), the MS subscriber's IMSI, LCS QoS information (e.g. accuracy, response time) and an indication of whether the LCS client has the override capability. The message shall carry the identity of the LCS client.

(5) If the GMLC is located in another PLMN or another country, the SGSN first authenticates that a location request is allowed from this PLMN or from this country. If not, an error response is returned. The SGSN then verifies LCS barring restrictions in the MS user's subscription profile in the SGSN. 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, the SGSN performs paging for location services. Paging is performed at the SGSN by sending a paging message indicating "Paging for LCS" to the RAN.

NOTE: "Paging for LCS" is for further study.

The MS may be paged for location services even when in UMTS a signaling connection between mobile station and the network is established and in GSM when in Ready Mode. This makes it possible for the MS to start preparing an anticipated location service coming later by e.g. starting to measure GPS signals.
In GSM upon receipt of a Packet Paging Request message indicating paging for LCS, the MS shall respond with a layer 3 LCS Paging Response.
In UMTS upon receipt of a Packet Paging Request message indicating paging for LCS, the MS shall send a Service Request to establish PS signalling connection.

(6) Security functions may be executed. These procedures are defined in TS 23.060[19].

(7) 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, a notification invoke message is sent to the target MS indicating the type of location request (e.g. current location) and the identity of the LCS client and whether privacy verification is required. Optionally, the SGSN may after sending the LCS Location Notification Invoke message continue in parallel the location process, i.e. continue to step 9 without waiting for a LCS Location Notification Return Result message in step 8.

(8) 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 notification result to the SGSN indicating, if privacy verification was requested, whether permission is granted or denied. Optionally, this message can be returned some time after step 7, but before step 12. If the MS user does not respond after a predetermined time period, the SGSN shall infer a "no response" condition. The SGSN 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.

(9) The SGSN sends a Location Request message to the RAN. This message includes the type of location information requested, the MS's location capabilities, the requested QoS and any other location information received in paging response.

## 10.1.4.2 Positioning Measurement Establishment Procedure

(10) If the requested location information and the location accuracy within the QoS can be satisfied based on parameters received from the SGSN and the parameters obtained by the RAN e.g. cell coverage and timing information (i.e. RTT or TA), the RAN may send a Location Report immediately. Otherwise, the RAN determines the positioning method and instigates the particular message sequence for this method in UTRAN Stage 2 TS 25.305 [1] and in GERAN Stage 2 TS 43.059 [16]. If the position method returns position measurements, the RAN uses them to compute a location estimate. If there has been a failure to obtain position measurements, the RAN may use the current cell information and, if available, TA or RTT value to derive an approximate location estimate. If an already computed location estimate is returned for an MS based position method, the RAN may verify consistency with the current cell and, if available, RTT oar TA value. If the location estimate so obtained does not satisfy the requested accuracy and sufficient response time still remains, the RAN may instigate a further location attempt using the same or a different position method. If a vertical location co-ordinate is requested but the RAN can only obtain horizontal co-ordinates, these may be returned.

### 10.1.4.3  Location Calculation and Release Procedure

(11) When location information best satisfying the requested location type and QoS has been obtained, the RAN returns it to the SGSN in a Location Report message. If a location estimate could not be obtained, the RAN returns a Location Report message containing a failure cause and no location estimate.

(12) The SGSN returns the location information and its age to the GMLC, if the SGSN has not initiated the Privacy Verification process in step 7. If step 7 has been performed for privacy verification, the SGSN returns the location information only, if it has received a LCS Location Notification Return Result indicating that permission is granted. If a LCS Location Notification Return Result message indicating that permission is not granted is received, or there is no response, with the MS subscription profile indicating barring of location, the SGSN shall return an error response to the GMLC. If the SGSN did not return a successful location estimate, but the privacy checks were successfully executed, the SGSN 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 SGSN may record billing information.

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

NOTE: Steps 9 – 13 may be repeated a number of times in case of periodic location request.

## 10.1.5  Packet Switched Network Induced Location Request (PS-NI-LR)

Figure 9.4 illustrates a network induced location request from the SGSN. This procedure may be used e.g. for positioning of an emergency call.
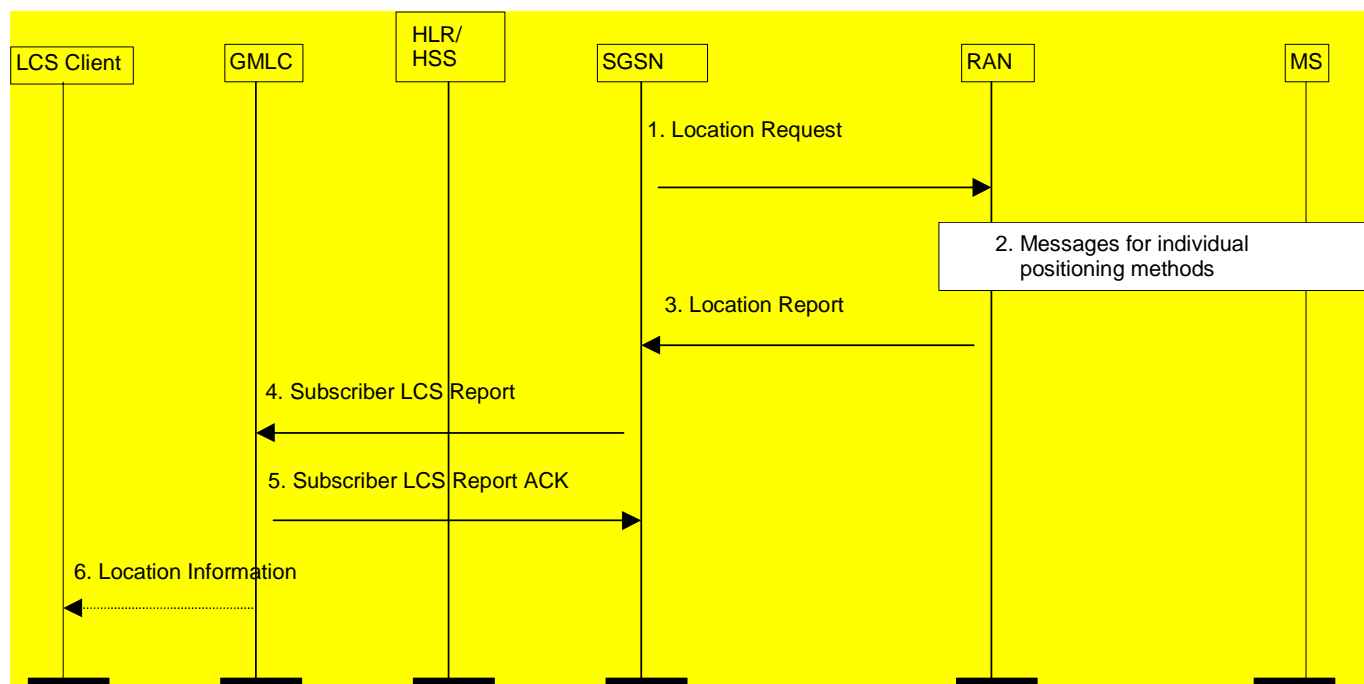


**Figure 9.4: Network Induced Location Request**

(1) The SGSN sends a Location Request message to the RAN. This message indicates the type of location information requested, the MS's location capabilities and requested QoS.

### 10.1.5.1  Positioning Measurement Establishment Procedure

(2)  If the requested location information and the location accuracy within the QoS can be satisfied based on parameters received from the SGSN and the parameters obtained by the RAN e.g. cell coverage and timing information (i.e. TA or RTT), the RAN may send a Location Report immediately. Otherwise, the RAN determines the positioning method and instigates the particular message sequence for this method in GERAN Stage 2 [16]. If the position method returns position measurements, the RAN uses them to compute a location estimate. If there has been a failure to obtain position measurements, the RAN may use the current cell information and, if available, TA or RTT value to derive an approximate location estimate. If an already computed location estimate is returned for an MS based position method, the RAN may verify consistency with the current cell and, if available, RTT oar TA value. If the location estimate so obtained does not satisfy the requested accuracy and sufficient response time still remains, the RAN may instigate a further location attempt using the same or a different position method. If a vertical location co-ordinate is requested but the RAN can only obtain horizontal co-ordinates, these may be returned.

### 10.1.5.2  Location Calculation and Release Procedure

(3)  When a location estimate best satisfying the requested QoS has been obtained , the RAN returns a Location Report to the SGSN. This message carries the location estimate that was obtained. If a location estimate was not succesfully obtained , a failure cause is included in the Location Report.

(4)  The SGSN shall send a MAP Subscriber Location Report to the GMLC obtained in step 1 carrying the MSISDN or PDP address of the MS, the identity of the LCS client, the event causing the location estimate (NI-LR-PS) and the location estimate and its age.

(5)  The GMLC shall acknowledge receipt of the location estimate provided that it serves the identified LCS client and the client is accessible.

(6)  The GMLC may transfer the location information to the LCS client either immediately or upon request from the client.

## 10.2    Mobile Originating Location Request

## 10.2.1   Mobile Originating Location Request, Circuit Switched (CS-MO-LR)

The following procedure shown in Figure 9.5 allows an MS to request either its own location, 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. The ciphering key enables 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 TS 24.008. The procedure may also be used to enable an MS to request that its own location be sent to another LCS client. [Editorial NOTE: The following text shall be alligned to support CS-MO-LR through the new network elements HSS and MSC Server, the impacts of A interface between core network and RAN shall be reflected in the text as well.]
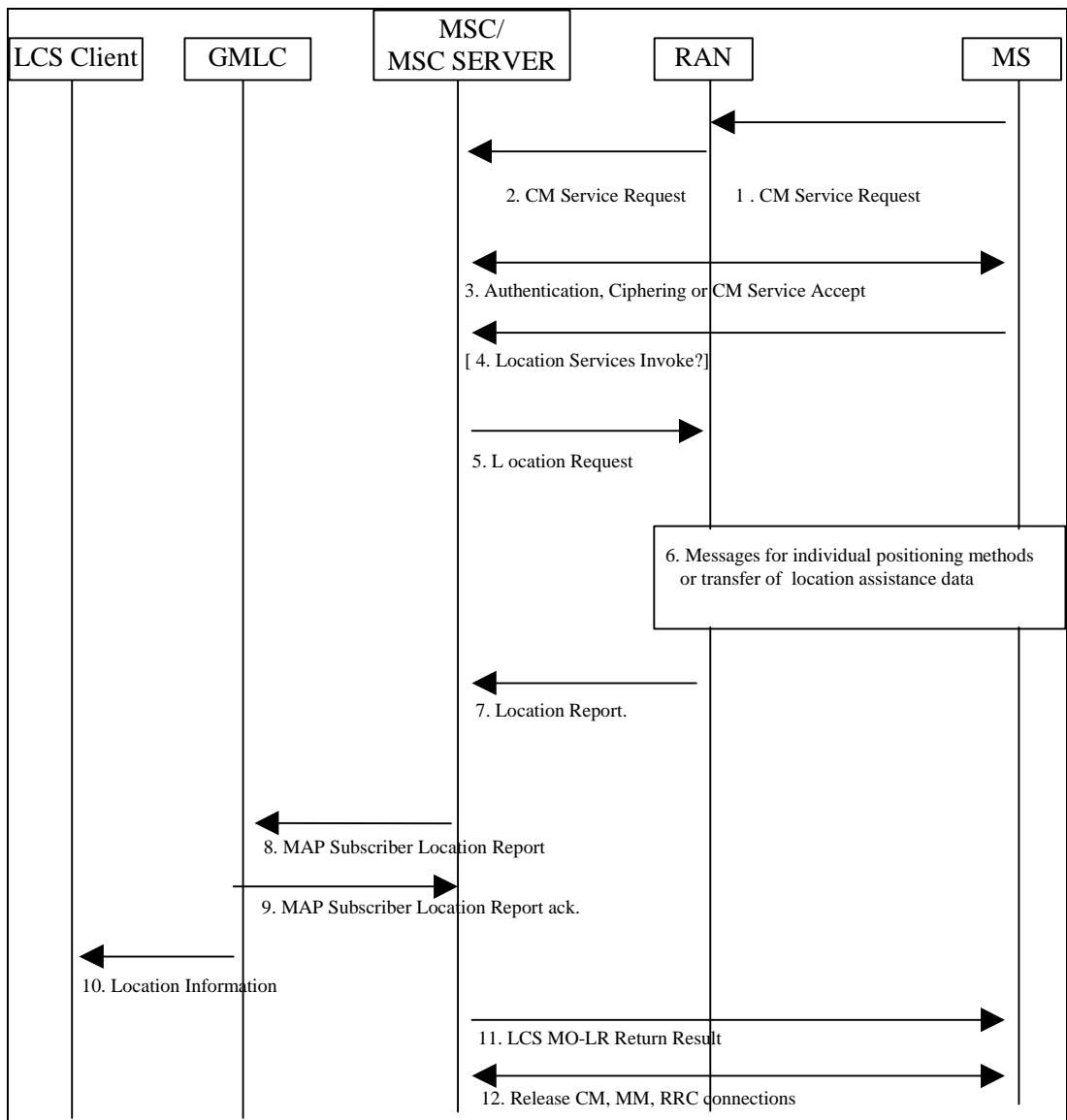
**Figure 9.5: General Network Positioning for MO-LR**

## 10.2.1.1 Location Preparation Procedure

1) If the MS is in idle mode, the MS requests an RACH and sends a CM service request indicating a request for a call independent supplementary services to the VMSC via RAN.

2) RAN shall convey the CM service request to the core network. If the MS is in dedicated mode, the MS sends a CM Service Request on the already established RACH.

3) The VMSC instigates authentication and ciphering if the MS was in idle mode or returns a Direct Transfer CM Service Accept if the MS was in dedicated mode. If the target MS supports any MS based or MS assisted positioning method(s), the MS will provide RAN and MSC with the positioning method(s) it supports via controlled early classmark sending in GSM or UE capability information in UMTS.

4)  The MS sends a 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 requested QoS information (e.g. accuracy, response time). 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 ciphering 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 Location Request message to RAN associated with the Target MS. The message indicates whether a location estimate or location assistance data is requested and includes the MS's location capabilities. If the MS's location is requested, the message also includes the requested QoS. If location assistance data is requested, the message carries the requested types of location assistance data.

## 10.2.1.2  Positioning Measurement Establishment Procedure

6)  If the MS is requesting its own location, the actions described under step 9 for a MT-LR are performed. If the MS is instead requesting location assistance data, RAN transfers this data to the MS as described in subsequent sections. RAN 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.

## 10.2.1.3  Location Calculation and Release Procedure

7)  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, RAN returns a Location Report to the VMSC. This message carries the location estimate or ciphering keys if this was obtained. 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 Location Report.

8)  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.

9)  The GMLC shall acknowledge receipt of the location estimate provided that is serves the identified LCS client and the client is accessible.

10) The GMLC transfers the location information to the LCS client either immediately or upon request from the client.

11) The VMSC returns an LCS MO-LR 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.

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

NOTE:    In case of positioning of emergency call stage 3 of the pervious sequence is naturally omitted.

## 10.2.2  Mobile Originating Location Request, Packet Switched (PS-MO-LR)

The following procedure shown in Figure 9.6 allows an MS to request either its own location; 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. A ciphering key enables the MS to decipher other location assistance data broadcast periodically by the network. The PS-MO-LR may be used to request ciphering keys or GPS assistance data. The procedure may also be used to enable an MS to request that its own location be sent to another LCS client.
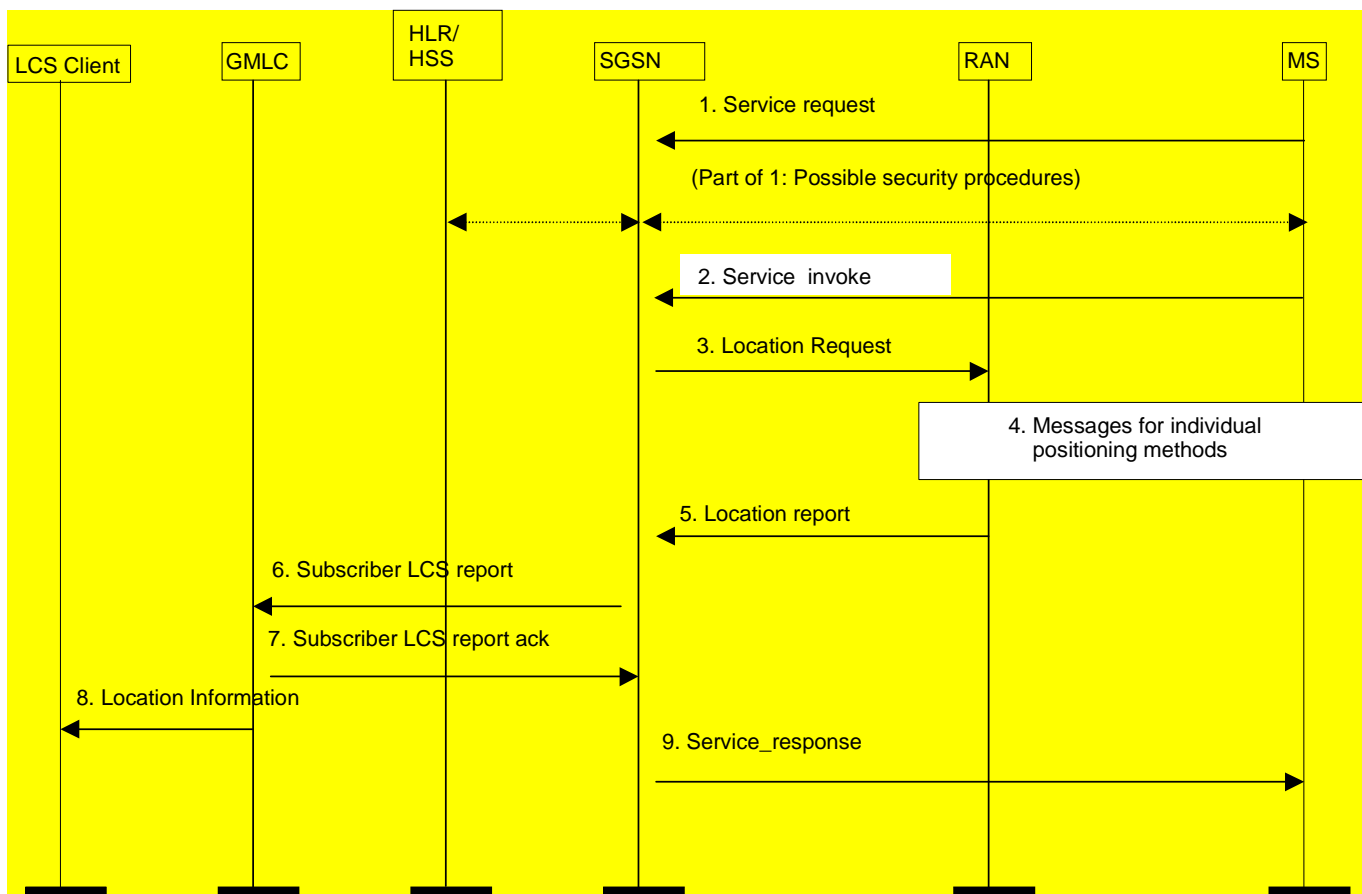
**Figure 9.6: General Network Positioning for packet switched MO-LR**

### 10.2.2.1  Location Preparation Procedure

(1) In UMTS, if the MS is in idle mode, the MS requests a PS signalling connection and sends a Service request indicating signaling to the SGSN via the RAN. If the MS already has PS signalling connection, the MS does not need to send Service request. Security functions may be executed. These procedures are described in TS 23.060[19].
In GSM this signaling step is not needed.

(2) The mobile station sends a service invoke message to the SGSN. Different types of location services can be requested: location of the MS, location of the MS to be sent to another LCS client, location assistance data or ciphering keys. If the MS is requesting its own location or that its own location be sent to another LCS client, this message carries LCS requested QoS information (e.g. accuracy, response time). 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 SGSN 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 SGSN 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 ciphering applies. The SGSN verifies the subscription profile of the MS and decides if the requested service is allowed or not.

(3) The SGSN sends a Location Request message to the RAN associated with the Target MS's location. The message indicates whether a location estimate or location assistance data is requested and includes theMS's location capabilities. If the MS's location is requested, the message also includes the requested QoS. If location assistance data is requested, the message carries the requested types of location assistance data. The message carries also location parameters received in the Service Invoke message.

### 10.2.2.2  Positioning Measurement Establishment Procedure

(4) If the MS is requesting its own location, the actions described in UTRAN Stage 2 TS 25.305 [1]or GERAN stage 2 TS 43.059 [16] are performed. If the MS is instead requesting location assistance data, the RAN transfers this data to the MS as described in subsequent sections. The RAN 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.

### 10.2.2.3  Location Calculation and Release Procedure

(5) 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 RAN returns a Location Report to the SGSN. This message carries the location estimate or ciphering keys if this was obtained. 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 Location Report.

(6) If the MS requested transfer of its location to another LCS client and a location estimate was successfully obtained, the SGSN shall send a Subscriber Location Report to the GMLC obtained in step 1 carrying the MSISDN or PDP address of the MS, the identity of the LCS client, the event causing the location estimate (MO-LR-PS) and the location estimate and its age.

(7) The GMLC shall acknowledge receipt of the location estimate provided that it serves the identified LCS client and the client is accessible.

(8) The GMLC transfers the location information to the LCS client either immediately or upon request from the client.

(9) The SGSN returns a Service Response message 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.

NOTE: Steps 3 – 9 may be repeated a number of times in case of periodic location request.

## 10.3  LCS signaling procedures specified in UTRAN and GERAN Stage 2

The signalling procedures in UTRAN and GERAN are defined in TS 25.305 [1] and TS 43.059 [16]respectively.

## 10.4  Exception Procedures

The procedures in this subclause apply to all variants of an MT-LR, NI-LR and MO-LR where a Location Request message has been sent to RAN requesting some location service (e.g. provision of a location estimate for a target MS or transfer of assistance data to a target MS).

### 10.4.1  Procedures in the VMSC

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

**Restart the Location Service**

This action shall be employed for any event that temporarily impedes a location service attempt and cannot be delayed until the location service attempt is complete. When such an event is notified to the VMSC, it shall immediately cancel the location service attempt and the associated signaling dialogue with RAN, if this still exists by sending a "stop

reporting" message to RAN. The "stop reporting" message shall contain the reason for the location procedure cancellation.

After aborting the location request dialogue with RAN, the VMSC may queue the location service request until the event causing the restart has terminated (if not already 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 RAN have time to be released. The VMSC may then send another location service request to RAN associated with the target MS.

**Abort the Location Service**

This action shall be employed for any event that permanently impedes a location service attempt, such as loss of the dedicated signaling channel to the target MS. When such an event is notified to the VMSC, it shall cancel the current location service attempt and the associated signaling dialogue with RAN, if still existing, by sending a "stop reporting" message to RAN. The "stop reporting" 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 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, the VMSC need take no action.

**Table 9.1: LCS Error Recovery Procedures in the VMSC for certain Events**

| Event | VMSC Error Recovery |
|---|---|
| Release of radio channel to the MS | Abort |
| Any error response from RAN except for inter-SRNC or inter-MSC handover | Abort |
| Inter-SRNC Handover | Restart after handover completed |
| Inter-MSC Handover | Restart after handover completed |

If the RNC is in an overload condition, it may reject a location request by indicating congestion. The MSC may reduce the frequency of future location service requests until rejection due to overload has ceased.

# 10.4.2   Procedures in the MSC Server

# 10.4.3   Procedures in the SGSN

# 10.4.4   Procedures in the MS

# 10.4.5   Further Procedures for Handover

[Editor's note: During soft and softer handovers in WCDMA (inter Node-B, inter RNC) the existing RRC connection can be used with no need for aborting the on-going positioning process. In case of hard handovers, e.g. inter RNC hard handover (or SRNC relocation) and inter CN (MSC, SGSN) handovers the same approach can be followed as for any service connection (e.g. call handover). Therefore, aborting the service requests, including LCS request, because of handovers is not needed.
The exception procedures and error cases in UMTS need to be further studied.]

## 10.4.5.1  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 location area ID shall be used by the visited MSC to identify the correct RAN to perform the location. All Location request related messages that are transferred over the Iu-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. The handling of LCS request during Inter-MSC handover in UMTS is FFS.]

### 10.4.5.2  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 RAN, the request shall be suspended until the handover is completed. On completion of the handover, RAN shall continue with location preparation procedure.]

# 10.5  Privacy

## 10.5.1  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. 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 as 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.

## 10.5.2  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, MSC Server and SGSN together with the rest of his subscription information in the existing  operation INSERT_SUBSCRIBER_DATA. It will be deleted with the existing  operation DELETE_SUBSCRIBER_DATA.

The POI is transferred from the GMLC to the VMSC/MSC Server/SGSN in the location request. Based on the location of the GMLC the VMSC/MSC Server/SGSN evaluates whether to accept or ignore the received POI according to the definition in subclause.

If the POI is accepted the location requested is unconditionally performed. Otherwise if the POI is ignored the VMSC/MSC Server/SGSN evaluates the privacy options in the MS subscriber's subscription profile (assuming this is held in the VLR/MSC Server/SGSN). If the corresponding register 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.

## 10.5.3  MS Privacy Options

The MS privacy options in the SLPP apply to an CS-MT-LR/PS-MT-LR or NI-LR/PS-NI-LR and either indicate that no CS-MT-LR/PS-MT-LR or NI-LR/PS-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 CS-MT-LR/PS-MT-LR or NI-LR/PS-NI-LR for location are allowed, with the following classes being possible:

   a)  Universal Class – allow positioning by all LCS clients

   b)  Call related Class – comprises any LCS client to which the MS originated a call in CS domain or a session via an active PDP context in PS domain that is currently established. For all clients in the call related class, one of the following subscription options shall apply:

   ▪  positioning allowed without notifying the MS user (default case)

   ▪  positioning allowed with notification to the MS user

- positioning requires notification and verification by the MS user; positioning is allowed only if granted by the MS user or if there is no response to the notification

- positioning requires notification and verification by the MS user; positioning is allowed only if granted by the MS user

- NOTE: The usage of  Call related Class in the IM subsystem is FFS..

- NOTE: A possible separate class for active PDP context is for further study.

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 GMLCs identified in the SLPP

- Location request allowed only from a GMLC in the home country

- Location request allowed from any GMLC (default case)

For each identified value added LCS client in the privacy exception list, one of the following subscription options shall apply:

- positioning allowed without notifying the MS user (default case)

- positioning allowed with notification to the MS user

- positioning requires notification and verification by the MS user; positioning is allowed only if granted by the MS user or if there is no response to the notification

- positioning requires notification and verification by the MS user; positioning is allowed only if granted by the MS user

For all value added LCS clients sending a non-call related CS-MT-LR/PS-MT-LR that are not identified in the privacy exception list, one of the following subscription option shall apply:

- positioning not allowed (default case)

- positioning allowed with notification to the MS user

- positioning requires notification and verification by the MS user; positioning is allowed only if granted by the MS user or if there is no response to the notification

- positioning requires notification and verification by the MS user; positioning is allowed only if granted by the MS user

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/MSC Server/SGSN. 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/MSC Server.

If the MS subscribes to the call-related class, an MT-LR may be allowed if the MS previously originated a call that is still established and the called party number or APN  either dialled by the MS or used by the VMSC/MSC Server/SGSN for routing matches the called party number or APN received from the GMLC. If the called party number /APN conditions are satisfied, the MT-LR shall be allowed if the MS user subscribes to either location without notification or

location with notification. If the MS user subscribes to location with notification and privacy verification, the MT-LR shall be allowed following notification to the MS if the MS user either returns a response indicating that location is allowed or returns no response but subscribes to allowing location in the absence of a response. In all other cases, the MT-LR shall be restricted.

If the MS subscribes to the non-call related class, an CS-MT-LR/PS-MT-LR may be 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 GMLC restrictions associated with this LCS Client identity in the SLPP are also met.

If the LCS client is correctly matched in this way and any GMLC restrictions are satisfied, the CS-MT-LR/PS-MT-LR shall be allowed if the MS user subscribes to either location without notification or location with notification. If the MS user subscribes to location with notification and privacy verification, the CS-MT-LR/PS-MT-LR shall be allowed following notification to the MS if the MS user either returns a response indicating that location is allowed or returns no response but subscribes to location in the absence of a response. In all other cases, the CS-MT-LR/PS-MT-LR shall be restricted.

If the MS subscribes to the non-call related class, an CS-MT-LR/PS-MT-LR from an LCS client that is not contained in the MS's SLPP shall allowed or restricted according to the following conditions. For any non-matched LCS client, the CS-MT-LR/PS-MT-LR shall be allowed if the MS user subscribes to location with notification. If the MS user subscribes to location with notification and privacy verification, the CS-MT-LR/PS-MT-LR shall be allowed following notification to the MS if the MS user either returns a response indicating that location is allowed or returns no response but subscribes to location in the absence of a response. In all other cases, the CS-MT-LR/PS-MT-LR shall be restricted.

If the MS subscribes to the PLMN class, an NI-LR/PS-NI-LR or CS-MT-LR/PS-MT-LR shall be allowed if the client within the VPLMN, for an NI-LR/PS-NI-LR, or the client identified by the GMLC, for an CS-MT-LR/PS-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 UEC/VLR in international format.

# 10.6 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.

**Table 9.2: Required MS Subscription Options for MO-LR Requests**

| 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 |

## 10.7 CM Procedures

### 10.7.1 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.

### 10.7.2 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.

# 11 Information storage

This clause 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. Information storage in RAN network elements is specified in UTRAN Stage 2 [1] and GERAN Stage 2 [16] specifications.

## 11.1 HLR and HSS

The HLR/HSS holds LCS data for both MS subscribers and LMUs.

### 11.1.1 LCS Data in the HLR/HSS for an MS Subscriber

The IMSI is the primary key for LCS MS subscription data in the HLR/HSS. This subscription data may be stored in a Multiple Subscriber Profile (MSP), with the HLR/HSS 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 23.011 for an explanation of the notation):

**Table10.1: Logical States for each LCS Privacy Class**

| 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) |

For each LCS privacy class, the HLR/HSS 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 clause 9 and to TS 22.071.

**Table 10.2: LCS data stored in the HLR privacy exception list for an MS Subscriber (or MS Subscriber MSP)**

| LCS Privacy Class | Status | Additional HLR Data when Class is provisioned |
|---|---|---|
| Universal Class | - | No additional data |
| Call Related Class | M | Indication of one of the following mutually exclusive options:<br>• Location allowed without notification (default case)<br>• Location allowed with notification<br>• Location with notification and privacy verification; location allowed if no response<br>• Location with notification and privacy verification; location restricted if no response |
| Call Unrelated Class | M | Indication of one of the following mutually exclusive options for any LCS client not in the external LCS client list:<br>• Location not allowed (default case)<br>• Location allowed with notification<br>• Location with notification and privacy verification; location allowed if no response<br>• Location with notification and privacy verification; location restricted if no response |
|  | O<br><br>C<br><br>C<br>C | External LCS client list: a list of zero or more LCS clients, with the following data stored for each LCS client in the list:<br>• International E.164 address identifying a single LCS client or a single group of LCS clients that are permitted to locate this target MS<br>• APN (see note to table 10.6.)<br>• [NOTE: IP address (IPv6,..) or another appropriate identity of the LCS Client, applicable in PS domain may be included] |
|  | O | • Restriction on the GMLC. Possible values are:<br>- identified GMLCs only<br>- Any GMLC in the home country |
|  | C | • Indication of one of the following mutually exclusive options:<br>- Location allowed without notification (default case)<br>- Location allowed with notification<br>- Location with notification and privacy verification; location allowed if no response<br>- Location with notification and privacy verification; location restricted if no response |
| 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:<br>• LCS client broadcasting location related information<br>• O&M LCS client in the HPLMN<br>• O&M LCS client in the VPLMN<br>• LCS client recording anonymous location information<br>• LCS Client supporting a bearer service, teleservice or supplementary service to the target MS |

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 TS 23.011 for an explanation of the notation):

**Table 10.3: Logical States for each Mobile Originating LCS Class**

| 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) |

For each LCS Mobile Originating class, the HLR/HSS 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 clause 8 and to GSM 22.071.

**Table 10.4: Data stored in the HLR for the LCS Mobile Originating List for an MS (or MS Subscriber MSP)**

| 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 |

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

**Table 10.5: Temporary LCS data in the HLR**

| Other Data in the HLR | Status | Description |
|---|---|---|
| GMLC List | O | List of one or more E.164 addresses of the GMLCs 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. |

# 11.2 VLR

The VLR contains the same LCS permanent data for each registered MS subscriber, as does the HLR/HSS. This data is downloaded to the VLR as part of the location update procedure between the VLR and HLR/HSS for an MS subscriber.

# 11.3 GMLC

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

**Table10.6: GMLC Permanent Data for a LCS Client**

| LCS Client data in GMLC | Status | Description |
|---|---|---|
| LCS Client Type | M | Identifies the type LCS client from among the following:<br>• Emergency Services<br>• Value Added Services<br>• PLMN Operator Services<br>• - 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 the present document |
| Authentication data | M | Data employed to authenticate the identity of an LCS client – details are outside the scope of the present document |
| Call related identity | O | A list of one or more international E.164 addresses or APNs (see NOTE) to identify the client for a call related MT-LR<br>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 or APNs to identify the client for a non-call related CS-MT-LR/PS-MT-LR.<br>NOTE: A list of IP addresses or other appropriate PS specific identities may be added here.<br>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:<br>• Accuracy<br>• Response time<br>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 of the following are allowed:<br>• Non-call related CS-MT-LR/PS-MT-LR<br>• Call related CS-MT-LR<br>• Specification or negotiation of priority<br>• Specification or negotiation of QoS parameters<br>• Request of current location<br>• Request of current or last known location |
| Local Co-ordinate System | O | Definition of the co-ordinate system(s) in which a location estimate shall be provided – details are outside the scope of the present document |
| Access Barring List(s) | O | List(s) of MSISDNs or groups of MSISDN for which a location request is barred |

NOTE: The LCS Client is identified with E.164 number or APN. APN is specified in TS 23.003 [18].
The APN identity of the LCS Client should be further defined, e.g. if it is global or GMLC related.

# 11.4 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 TS 23.007.

# 12 Operational Aspects

## 12.1 Charging

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 co-ordinate system used.

## 12.2 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, MSC Server, SGSN, location area ID, cell ID, location co-ordinates);

- 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).

# Annex A (informative):
# Change history

| Date | Version | Comment |
|---|---|---|
| 10 July 2000 | 0.1.0 | |
| 11 September 2000 | 0.2.0 | Combined document from S2 LCS drafting session 7 September 2000 |

| 15 September | 0.2.1 | Corrections in chapter 9 figures, note added in definitions chapter |
| 20 September 2000 | 0.2.2 | Added sentence in scope about TS 23.171 and GSM 03.71 |
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# History

| **Document history** | | |
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