

## Procedures in digital PLMNs for positioning of Mobile Terminals at Emergency Calls

*An Application Guide for procedures in digital PLMNs for the support of positioning of mobile terminals at Emergency Calls*

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## 1 Introduction

This Application Guide is released as an informative complement to the Swedish Standard SS636394 – Positioning of Mobile Terminals at Emergency Calls. The purpose of the Application Guide is to describe procedures that can be used inside a Public Land Mobile Network for the support of positioning of mobile terminals at Emergency Calls. To get the full understanding of the procedures and interfaces between public communications networks and the Emergency Services Operator for the support of positioning of mobile terminals at Emergency Calls, this Application Guide should be read together with the above-mentioned Swedish Standard.

The document describes technical issues. It is assumed that the public communications operators concerned and the Emergency Services Operator sign mutual commercial agreements on interconnection, traffic cases, routing, services, traffic volumes, accounting procedures, information integrity, prices, etc.

## 2 Scope

The objective of the emergency location service is to enable retrieval of the position of a digital mobile terminal making an Emergency Call, irrespective of the subscriber's status in the Home Location Register (HLR).

To facilitate fulfilment of the stated objective, some additional information has to be conveyed from the originating mobile network to the Emergency Services Operator. The Emergency Services Operator will be able to perform an emergency location request, with help of the received information. The Swedish Standard, SS636394 is produced in order to control the format of information sent from the digital PLMNs with the Emergency Call and also the interface and procedures to be used for the emergency location request. This Application Guide is written to describe possible procedures in a digital PLMN.

This Application Guide,

- Describes the procedures that are intended to be used inside a digital PLMN,
- Describes the parameters and information elements supporting the positioning of mobile terminals.

The Swedish Standard,

- Describes the general procedures for positioning of a digital mobile terminal making an Emergency Call in Sweden,
- Describes the ISUP parameter Location Number to be used on calls from a digital PLMN to the emergency services operator;
- Describes the Mobile Location Protocol, MLP to be used for emergency location request by the emergency services operator,
- Describes the mapping of information elements between ISUP and MLP,
- Is based on White Book-level ISUP implementation between the public communications networks and the Emergency Services Operator,
- Is applicable for national interconnect ISUP specifications between public communications networks in Sweden that are Telia's specifications 8211-A335 rev C; and 8211-A325 rev C and Swedish Standard SS636393, 2000, release 1.

## 3 Normative references

The following normative documents contain provisions, which through reference in this text constitute provisions of this Application Guide. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply.

However, parties having agreements based on this Application Guide are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below.

3GPP TS 23.271 v6.2.0 (2002-12)	Functional Stage 2 description of LCS (Release 6)
CGALIES final report (2002-02-18)	Report on implementation issues related to access to location information by emergency services (E112) in the European Union
ITU-T Rec. Q.763 (12/1999)	Format and codes of the ISDN user part of signalling system No. 7
LIF TS 101(V3.0.0)	Mobile Location Protocol
SS636393, 2000. release 1	PSTN/ISDN – PLMN(GSM)/ISDN signalling interface for Sweden
SS636394, 2004, release 1	Positioning of Mobile Terminals at Emergency Calls
Telia 1/8211-A325 Rev A	Annex 1 (8211-A325)
Telia 1/8211-A335 Rev A	Annex 1 (8211-A335)
Telia 8211-A325 Rev A	ISDN-PLMN (GSM) signalling interface for Sweden
Telia 8211-A335 Rev C	ISDN-ISDN signalling interface for Sweden
Telia ISUP 1056-A629 PF1 (1999-08-04)	Requirement Specification for ISUP in Telia Network

## 4 Terms and definitions

### 4.1 Emergency Call

A call made to a Public Service Answering Point. In Sweden the emergency numbers that can be used are 112 or 90 000 according to “The Swedish numbering plan for telephony according to ITU-T recommendation E.164, appendix 2b”.

### 4.2 Emergency Operator

The person receiving an Emergency Call at a Public Service Answering Point.

### 4.3 Emergency Services Operator

The PSAP operator providing access to the public communications network for support of incoming Emergency Calls. In Sweden today the PSAP operator is SOS Alarm.

### 4.4 Global Title (GT)

A unique address set and used of SCCP of Signalling System number 7. This specific address can be used to globally address (identify) each SCCP-node. The GT-address can also be used to implicitly identify the network (operator) that the GT belongs to, as addresses are nationally and internationally coordinated.

### 4.5 Location or Positioning Procedure

The procedure of finding the position of a mobile terminal.

**4.6 Mobile Location Protocol (MLP)**

A protocol used between a location server and a location client for support of the location request and response procedure.

**4.7 MSISDN**

Mobile Station International ISDN Number. The format of the MSISDN is Country Code + National Destination Code + Subscriber Number, CC+NDC+SN.

**4.8 Originating PLMN**

A network of the mobile operator where the Emergency Call was originated.

**4.9 Position**

The successful result of a positioning (or location procedure).

**4.10 Public Service Answering Point, (PSAP)**

The call centre connected to the public communications network receiving Emergency Calls. (In Sweden called "Larmcentral", abbreviated LAC.)

**5 Symbols and abbreviations**

GT	Global Title of SCCP, using E.214 numbering plan
HLR	Home Location Register
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
MAP	Mobile Application Part of SS7, for GSM and UMTS.
MLP	Mobile Location Protocol, according to LIF TS 101
ME	Mobile Equipment: Terminal without subscriber software
MS	Mobile Station: ME + SIM, working handset for GSM networks
MSC	Mobile Switching Centre
PLMN	Public Land Mobile Network
PSAP	Public Service Answering Point
SCCP	Signalling Connection Control Part of SS7, according to ITU-T Q.711-Q.716.
SIM	Subscriber Identification Module: Used for 2G terminals
SS7	Common Channel Signalling system number 7, according to ITU-T Q.700 series
UE	User Equipment: ME + USIM, working handset for UMTS networks
USIM	UMTS Subscriber Identification Module: Used for 3G terminals

**6 Methods and procedures for location of mobile terminals for emergency services****6.1 General**

The interface between the mobile network operators and the Emergency Services Operator is defined in such a way that it supports two principally different

methods for the positioning of mobile terminals making Emergency Calls. These are called:

- A-number based Location Request
- Cell-ID based Location Request

A-number based Location Request, as defined in this Application Guide, is the method that can be used by mobile network operators having implemented Location Servers.

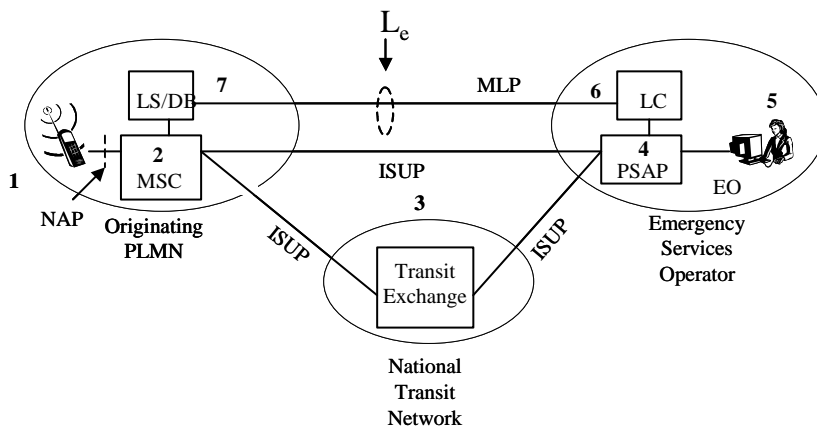
Cell-ID based Location Request, as defined in this Application Guide, is the method that can be used by mobile network operators preferring to use a database mapping cell-identity to geographical coordinates of the cells coverage.

Location of mobile terminals requires information to be sent from the mobile network where the call was originated to the Emergency Services Operator for performing the query for location. For A-number based Location Request the information that the query is based upon is the A-number of the calling terminal.<sup>1</sup> For Cell-ID based Location Request the information that the query is based upon is the cell-identity of the cell that the call originated in.

The choice of method to be used by a mobile network operator does not impact the systems of the Emergency Services Operator i.e. the information sent to the Emergency Services Operator for the location request passes transparently and is used by the originating mobile network operators systems for determining the location of the caller. One effect of this is that the choice of method in one digital PLMN will not affect other PLMNs.

### 6.2 General procedure

The general procedure for emergency location of mobile terminals making Emergency Calls is described below, see Picture 1.



Picture 1

1. A mobile terminal makes an Emergency Call.<sup>2</sup>

<sup>1</sup> Note: If an emergency call is made from a terminal without a SIM-card, the implementation of positioning may be operator specific

<sup>2</sup> In Sweden by dialling 112 or 90000.

2. The call is switched by the originating MSC.
3. The call is routed using ISUP, either directly or via a national transit network.
4. The call reaches the Public Service Answering Point, PSAP.
5. The Emergency Operator answering the call decides to get the position of the calling terminal.
6. A location request is sent from the location client to the location server or cell-identity database in the mobile network.
7. The mobile network answers by sending the location of the mobile terminal to the location client.

### **6.3 Information sent in Initial Address Message of ISUP**

#### **6.3.1 Calling Party's Number**

Shall always be present when the MSISDN is available at originating MSC.

Coding of the parameter shall be according to ITU-T Q.763.

#### **6.3.2 Location Number**

The Location Number parameter is used for transferring information concerning originating network and node. This is conveyed as a SCCP Global Title. The coding is a digit string used as described below. The detailed coding is described in Swedish Standard SS636394.

##### Coding description

Digits 1 to N: First N digits of Mobile Global Title according to E.214 allocation.

##### Example 1: Digits 1 to N for A-number based location request

A string "46705000111" is generated for a call initiated in TeliaSonera Sweden mobile network. The first six digits, 467050, belong to the address-series that is allocated to TeliaSonera Sweden Mobile, i.e. it implies TSS Mobile is the Originating PLMN operator.

##### Example 2: Digits 1 to N for Cell-ID based location request

A string "467075620173281" is generated for a call initiated in Tele2 mobile network. The first five digits, 46707, belong to the address-series that is allocated to Tele2 mobile network, i.e. it implies Tele2 is the Originating PLMN operator.

Digits (N+1) to 16: Used for support of location method chosen by network operator

The maximal number of address digits is 16. The actual number used by a certain Originating PLMN is operator specific.

##### Example 3: Digits (N+1) to 16 for A-number based location request

A string "46705000111" is generated for a call initiated in TeliaSonera Sweden mobile network. The whole string is a true E.214 network address (mobile Global Title) uniquely identifying the serving MSC under which the Emergency Call was originated.

#### Example 4: Digits (N+1) to 16 for Cell-ID based location request

A string “467075620173281” is generated for a call initiated in Tele2 mobile network. The last ten digits, 5620173281<sup>3</sup>, is a network internal unique identification of the location area and cell in Tele2 mobile network where the Emergency Call was originated.

All digital PLMN operators must inform the Emergency Services Operator what unique address series will be used for identifying the Originating PLMN, i.e. digits 1 to N.

The length of the first part, i.e. digits 1 to N, is variable and depending on the allocation given to the PLMN in the Swedish Numbering Plan. The number of digits used, N, must be sufficient for a unique identification of the PLMN.

All received Location Number parameter digits (up to 16) are transparently put into the MLP-protocol when making an emergency positioning, see chapter 6.5. Interpretation of the digits at an emergency positioning request is a network internal issue for the originating PLMN operator.

### **6.3.3 Parameter Compatibility Information**

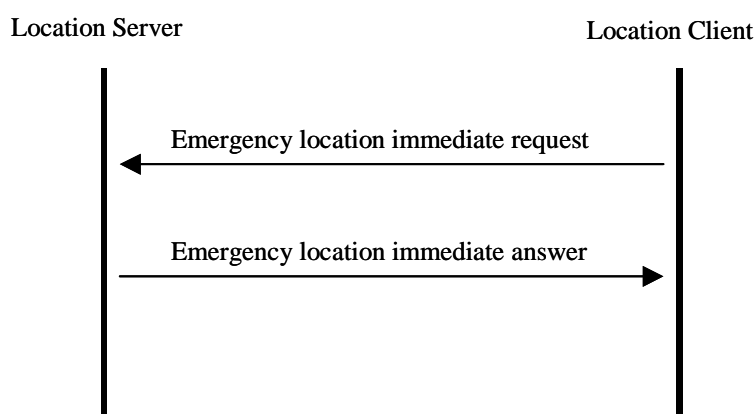
The setting of the ISUP parameter Compatibility Information for the Location Number shall be coded as described in Swedish Standard SS636394.

### **6.4 Information sent in Mobile Location Protocol**

If the Emergency Operator at the PSAP decides to invoke a location request after having received an Emergency Call from a digital PLMN, the Emergency Location Immediate Service defined in Mobile Location Protocol is used. The version of the MLP implementation for Location Enhanced Emergency Call services in Sweden is specified in LIF TS 101 V3.0.0.

#### **6.4.1 Emergency Location Immediate Service**

The Emergency Location Immediate Service is used to retrieve the position of a mobile subscriber that is involved in an Emergency Call or have initiated an emergency service in some other way.



**Picture 2**

The service consists of the following messages.

- Emergency Location Immediate Request
- Emergency Location Immediate Answer

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<sup>3</sup> String 56201 is LAC (Location Area Code), string 73281 is Cell-ID.



The message flow describing the service is shown in Picture 2.

### 6.5 Transfer of information received in the emergency call

The information received in ISUP in the incoming call should be mapped to the corresponding parameters in Mobile Location Protocol, see Table 1.

Parameter in ISUP	Element in MLP
Calling Party Number - A subscribers MSISDN, present if available	msisdn
Location Number - Mobile Global Title of MSC, or for the Cell-ID method, a string using similar format	vmscno

**Table 1**

The underlying Internet protocol connectivity for the MLP protocol shall be secured by appropriate means.

#### 6.5.1 Comments on availability of Calling Party Number

Calling Party Number should always be sent. For the positioning call cases where Calling Party Number is not available any other identification agreed by the industry should be sent.

#### 6.5.2 Comments on use of Global Title

The first part of the Global Title identifying the originating network will be used by the Emergency Services Operator for deciding which network to send the location request to.

The Originating PLMN operator uses the remaining digits of the Global Title string, for supporting either A-number based or Cell-ID based Location Request. These digits are not interpreted by the systems of the Emergency Services Operator.

The complete Global Title as received is sent further in the location request in MLP

### 6.6 Positioning call cases

The following call cases for positioning of mobile terminals shall be supported. See Table 2.

	Emergency call setup-case	Comment	Identifier of the mobile subscriber
1	Terminal with a valid SIM/USIM in the home network	Note 1.	Subscribers MSISDN
2 a	Terminal with a valid SIM/USIM in another, visited national network	National roaming. Note 1.	Subscribers MSISDN
2 b	Terminal with a valid non-Swedish	International (inbound) roaming. Note 1.	Subscribers MSISDN

	SIM/USIM in the visited network	Note 1.	MSISDN
3	Terminal without a valid/recognised SIM/USIM	<ul style="list-style-type: none"> <li>- No radio coverage by the subscribers operator, but instead by another Swedish operator (without national roaming agreement)</li> <li>- International inbound roaming attempt, agreement missing</li> <li>- SIM/USIM-card not activated</li> <li>- No PIN code authentication performed</li> <li>- Any other conditions when the IMSI from SIM/USIM will be unrecognised to the network.</li> <li>- Prepaid subscriber with an empty balance. Note 2</li> </ul>	Subscribers positioning not supported. Location of the mobile terminal based on the serving cell might work.
4	Terminal without SIM/USIM-card	<ul style="list-style-type: none"> <li>- No SIM/USIM inserted into terminal</li> <li>- A damaged SIM/USIM inserted</li> </ul>	Subscribers positioning not supported. Location of the mobile terminal based on the serving cell might work.

**Table 2**

Note 1. The cases 1, 2 a and 2 b will behave as the case 3, if the Emergency Call is set up before the GSM or UMTS authentication and location update procedures are fully performed by the network. No other calls than emergency calls can be done within this short initial period.

Note 2. Implementation specific. Can also work as case 1 for Emergency Calls.

The Emergency Call positioning using the methods described in this Application guide should be made as soon as possible after call setup to obtain the best precision and likelihood for a successful result.

For all Emergency Call cases where the mobile subscribers identity is known it may be possible to make additional location information requests<sup>4</sup> for updated location information. Consecutive positioning shall be possible within a reasonable time from when the call was originally made.

### 6.7 Comments on use of A-number based Location Request

A-number based Location Request as defined in this Application Guide is a method relying on implementation of location servers in the PLMN. There are several positioning methods that can be used inside the PLMN, e.g.:

- Cell-ID
- Cell-ID with Timing Advance (Cell-ID + TA)

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<sup>4</sup> Consecutive positioning

- Enhanced Cell Global identity (E-CGI)
- Enhanced Observed Time Difference (E-OTD)
- Assisted Global Positioning System (A-GPS)

The choice of method inside a PLMN is an internal matter. For more information see CGALIES Final Report 2002-01-28.

The A-number based Location Request will initially not support Emergency Calls without MSISDN. It will also be up to the mobile network operator to present what call cases in section 6.6 that will be supported.<sup>5</sup>

### **6.8 Comments on use of Cell-ID based Location Request**

Cell-ID based Location Request as defined in this Application Guide is a method assuming implementation of a cell-identity database. The database must support MLP-interface as required in the Swedish Standard SS636394 and be able to provide updated mapping of the identity of a cell into geographical representation.

This method will be able to support all call cases as described in section 6.6 since it does not rely on receipt of an A-number. On the other hand it will only support obtaining the cell-area of the cell where the emergency call was originated. In case consecutive positioning initiated from the Emergency Operator on a moving caller it might not give the correct cell.

## **7 Informative descriptions of procedures in mobile networks**

In this chapter descriptions of location procedures inside the mobile networks are given. The descriptions should be seen as informative since this Application Guide assumes network integrity and the procedure chosen by a PLMN operator inside own network is an internal matter.

### **7.1 Procedures in digital PLMN for A-number based Location Request**

#### **7.1.1 Ordinary Positioning**

The Ordinary Positioning is defined to be the method that can be used by the mobile network operators without any changes or additions to the existing positioning procedures. It is the standardised method where HLR-request is included. Since this requires knowledge of the Home Network of the calling subscriber it is likely that only positioning case 1 in section 6.6 will be supported by operators using this method.

1. A MLP “Emergency Location Immediate Request” is sent from the location client of the Emergency Service Operator to the location server in the PLMN. MSISDN and VMSC-identity<sup>6</sup> are transferred. See Picture 3.
2. The MAP message “Send Routing Information for Location” containing MSISDN is sent to the HLR of the caller.<sup>7</sup>
3. The HLR answers by sending IMSI and the VMSC-identity..

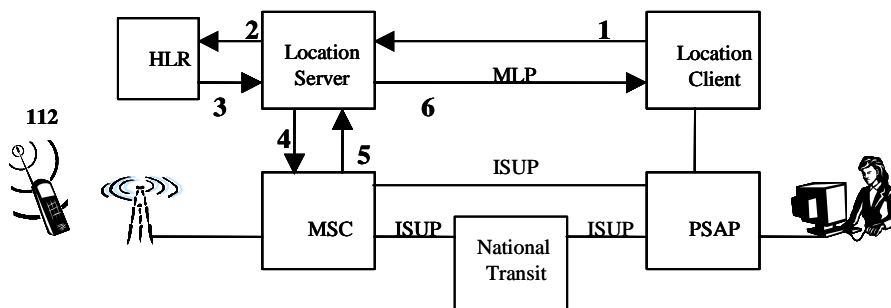
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<sup>5</sup> This is described in the agreement between the Emergency Services Operator and the mobile network operator.

<sup>6</sup> In this procedure the sending of VMSC identity from the emergency services operator is redundant.

<sup>7</sup> Requires that the HLR recognizes the MSISDN. MSISDNs not belonging to that network will give an error response.

- The MAP message “Provide Subscriber Location” is sent to the serving (visited) MSC, VMSC. The calling terminal is addresses by the calling subscribers IMSI.



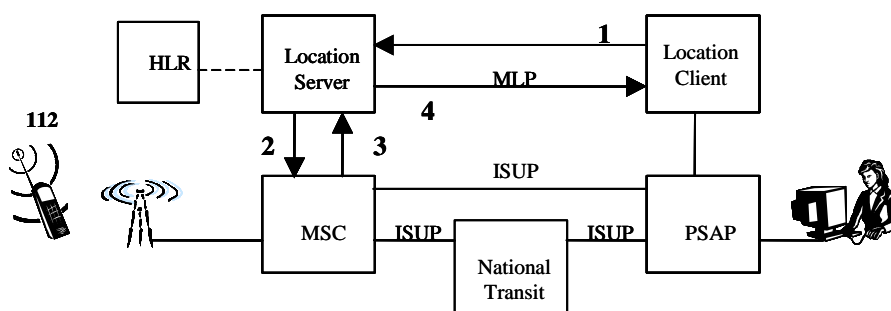
**Picture 3**

- The VMSC answers by sending the MAP message “Provide Subscriber Location ack.” to the location server.
- The location server sends the MLP message “Emergency Location Immediate Answer” to the location client.

### 7.1.2 Exclusive Emergency Positioning<sup>8</sup>

The Exclusive Emergency Positioning is defined to support positioning call cases with roaming subscribers. It is an optional method where HLR-request is excluded. The location server uses the received VMSC-identity for sending a location request directly to the correct VMSC. Without this information it would not be possible.

- A MLP “Emergency Location Immediate Request” is sent from the location client of the Emergency Service Operator to the location server in the PLMN. MSISDN and VMSC-address are transferred. See Picture 4.



**Picture 4**

- The MAP message “Provide Subscriber Location” is sent directly to the serving (visited) MSC, VMSC. The calling terminal is addressed by the calling

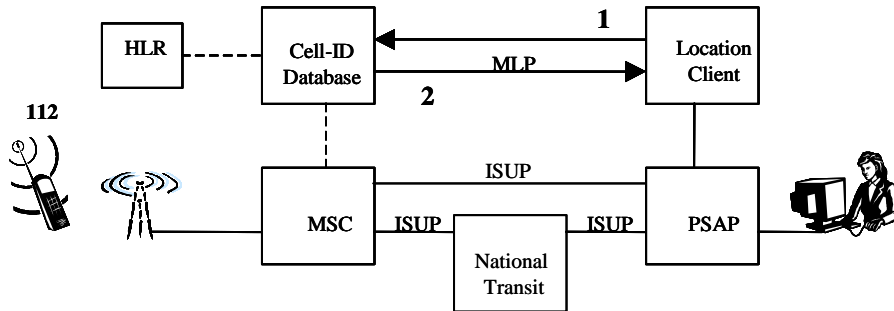
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<sup>8</sup> Compare “3GPP TS 23.271 v6.2.0” chapter “9.1.3 CS-MT-LR without HLR Query – applicable to North America Emergency Calls only”.

subscribers MSISDN. Notice that since no HLR-query is made IMSI is not available<sup>9</sup>.

3. The VMSC answers by sending the MAP message “Provide Subscriber Location ack.” to the location server.
4. The location server sends the MLP message “Emergency Location Immediate Answer” to the location client.

## 7.2 Procedures in digital PLMN for Cell-ID based Location Request



Picture 5

1. A MLP “Emergency Location Immediate Request” is sent from the location client of the Emergency Service Operator to the cell-identity database in the PLMN. MSISDN and cell-identity are transferred. See Picture 5.
2. The cell-identity database converts the cell-identity to relevant coordinates and answers by sending the MLP message “Emergency Location Immediate Answer” to the location client.

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<sup>9</sup> Using MSISDN to identify the target MS/UE is not according to standards for European Emergency services, but it is standard for North American Emergency Calls. See “3GPP TS 23.271 v6.2.0” chapter 9.1.3 §2