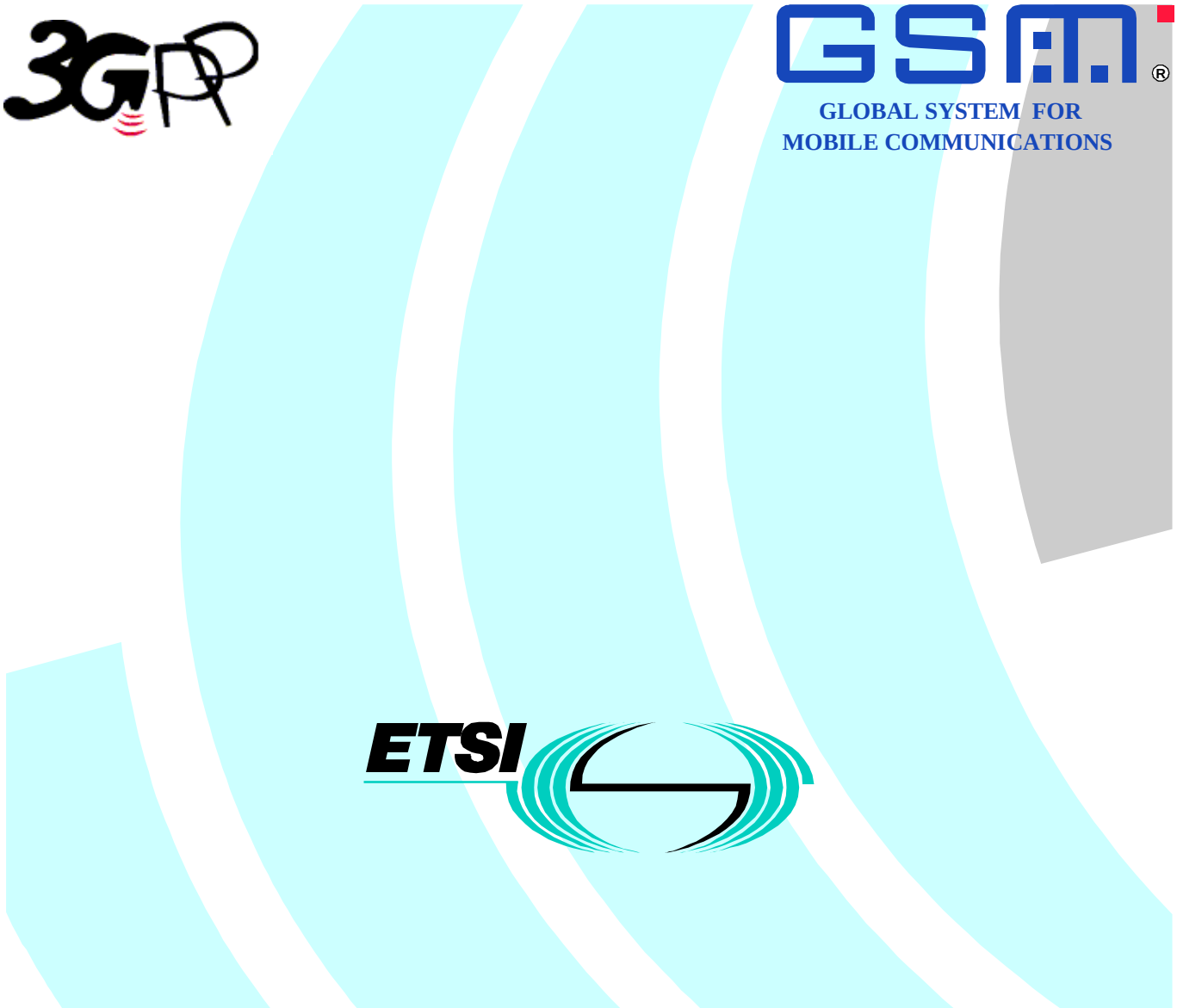
ETSI TS 101 725 V7.3.0 (2001-06)

Technical Specification

Digital cellular telecommunications system (Phase 2+);
Location Services (LCS);
Mobile radio interface layer 3
Location Services (LCS) specification
(3GPP TS 04.71 version 7.3.0 Release 1998)



Reference
RTS/TSGG-020471Q7R3

Keywords
GSM

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Intellectual Property Rights

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

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

Foreword

This Technical Specification (TS) has been produced by the ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under www.etsi.org/key .

Contents

Intellectual Property Rights

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

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

Foreword

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

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

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

Version 7.x.y

where:

7 GSM Phase 2+ Release 1998;

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

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

1 Scope

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

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

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

This version does not support segmentation of messages.

2 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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 01.04: "Abbreviations and acronyms".

[2] 3GPP TS 04.06: "Mobile Station - Base Station System (MS - BSS) interface Data Link (DL) layer specification".

[3] 3GPP TS 04.07: "Mobile radio interface signalling layer 3; General aspects".

[4] 3GPP TS 04.08: "Mobile radio interface layer 3 specification".

[5] 3GPP TS 03.71: "Location Services (LCS); (Functional description) - Stage 2"

[6] 3GPP TS 09.02: "Mobile Application Part (MAP) specification".

[7] ASN.1 encoding rules “Specification of Packet Encoding Rules (PER)” ITU-T Rec. X.691 (1997) | ISO/IEC 8825-2:1998

[8] ASN.1 encoding rules “Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)” ITU-T Rec.X.690 (1997) | ISO/IEC 8825-1:1998

[9] Abstract Syntax Notation One (ASN.1) “Specification of Basic Notation” ITU-T Rec.X.680 (1997) | ISO/IEC 8824 – 1:1998 [10] ITU-T Recommendation Q.773: "Transaction capabilities formats and encoding".

[11] Void.

3 Abbreviations

Abbreviations used in the present document are listed in 3GPP TS 01.04 and 3GPP TS 03.71.

4 Generic procedures for the control of location services

4.1 Overview of the generic protocol and its scope

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

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

4.2 Functional procedures for the control of location services

4.2.1 General

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

The functional protocol utilizes functions and services defined in 3GPP TS 04.08 and the functions of the data link layer as defined in 3GPP TS 04.06. This protocol utilizes also definitions in 3GPP TS 04.07.

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

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

4.2.2 Common Information Element Category

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

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

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

4.2.3 Location service procedures

4.2.3.1 Introduction

For location service procedures independent of any call, the initiating side must establish a MM-connection between the network and the LMU according to the rules given in 3GPP TS 04.07 and 04.08. The LMU or the network starts the transaction by transferring a REGISTER message across the radio interface. This transaction is identified by the transaction identifier associated with the REGISTER message present in the component part of the Facility information element. Following the REGISTER message one or more FACILITY messages may be transmitted, all of them related by the use of the same transaction identifier. If the transaction is no longer used, it shall be released by sending a RELEASE COMPLETE message. This procedure is specified in detail in clause 5, and the text in clause5 takes precedence over this introduction.

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

When the REGISTER or FACILITY message contains a Facility information element and the requested service is available, a FACILITY message containing a Facility information element may be returned. One or more exchanges of FACILITY messages may subsequently occur. To terminate the service interaction and release the transaction identifier value, a RELEASE COMPLETE message is sent as specified for the specific location service procedure. The RELEASE COMPLETE message may also contain the Facility information element.

4.2.3.2 Handling of protocol errors in LCS procedures

Messages containing a Facility information element shall be checked for protocol errors before the contents of the Facility IE is acted on. The checks shall be performed in the following order:

1) The message carrying the Facility IE shall be checked for protocol errors as specified in subclause 3.7. If a protocol error is found then the procedures in subclause 5.7 apply.

2) The contents of the Facility IE shall be checked for protocol errors as specified in subclause 4.2.6. If a protocol error is found then the procedures in subclause 4.2.6 apply.

4.2.3.3 Handling of other errors in LCS procedures

If the tests specified in subclause 4.2.3.2 have been passed without the detection of a protocol error, the receiver will attempt to process the contents of the Facility Information Element. If errors occur during this processing (e.g. system failure, or information in the Facility IE is incompatible with the requested operation) then the procedures specified in the individual service specifications apply.

An example of the behaviour that could occur in this case is:

- the LMU or network sends a Facility information element containing a return error component in a FACILITY or RELEASE COMPLETE message. If the FACILITY message is used then the MM Connection may continue to be used for further signalling.

4.2.4 Multiple location service invocations

It is possible for several LCS transactions to be used simultaneously. LCS transactions can also exist in parallel with other CM-Layer and MM transactions. The handling of multiple MM connections is defined in 3GPP TS 04.07 and 04.08.

A single Facility Information Element shall not contain more than one component.

4.2.5 Recovery procedures

In case a transaction is not terminated according to the normal procedure as described in this specification the network side has to ensure that the transaction is terminated e.g. by a supervision timer.

4.2.6 Generic protocol error handling for the component part of location services operations

If a location service operation is to be rejected the operation will be denied, and provided the transaction is still in progress, an appropriate reject component will be returned in a Facility Information Element.

4.2.6.1 Single component errors

The reject component shall be sent in a RELEASE COMPLETE message.

If the component containing the error was itself sent in a RELEASE COMPLETE message then the contents of the component shall be ignored, and no reject component is sent.

4.2.6.2 Multiple component errors

If a single Facility IE contains more than one component then a RELEASE COMPLETE message with the cause "Facility rejected" and without any component shall be sent.

5 Location service support procedures

5.1 General

This clause describes the location service support procedures at the radio interface. These procedures are provided by the location service support entity defined in 3GPP TS 04.07. The location service support procedures provide the means to transfer messages for the location service procedures. These procedures are regarded as the user of the location service support.

5.2 Location service support establishment

At the beginning of each location service procedure a location service support must be established.

5.2.1 Location service support establishment at the originating side

If the entity that uses the location support procedures needs to send a REGISTER message, the location service support entity shall first request the establishment of an MM-connection. This MM-connection is established according to 3GPP TS 04.08 and 04.07. If the network is the initiating side then MM-connection establishment may involve paging the LMU.

The location service support entity shall send the REGISTER message as the first CM-message on the MM-connection. The REGISTER message is sent to the corresponding peer entity on the MM-connection and the location service support shall be regarded as being established.

5.2.2 Location service support establishment at the terminating side

At the terminating side a location service support is regarded as being established when an MM-connection is established. According 3GPP TS 04.08 this can be ascertained by the receipt of the first message, with a new transaction identifier. For successful establishment of location service support this message shall be a REGISTER message.

If the terminating side needs to reject the establishment of location services support then it may be immediately initiate location services support release (see subclause 5.4).

5.3 Location service support information transfer phase

After the establishment of the location service support both users may exchange FACILITY messages by use of the location service support.

5.4 Location service support release

At the end of each location service procedure the established location service support is released, if a permanent connection is not used.

The side closing the transaction shall release the transaction by sending the RELEASE COMPLETE message to its corresponding peer entity.

Both location service support entities release the MM-connection locally.

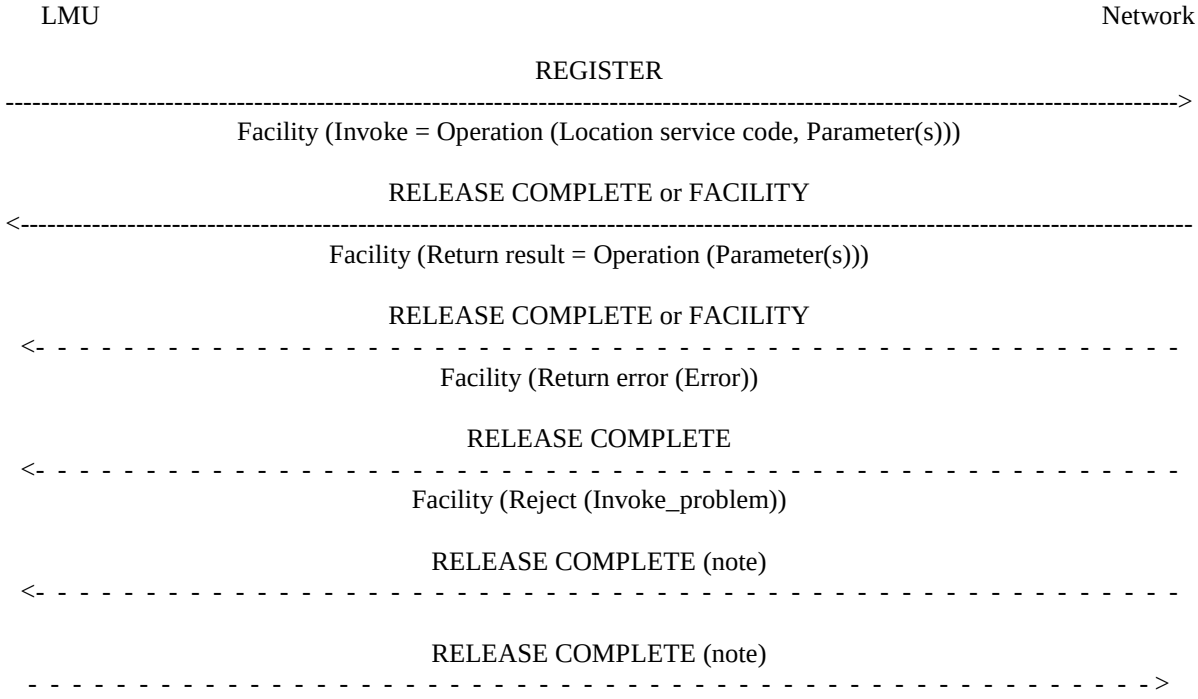
5.5 Recovery procedures

The location service support does not provide recovery procedures, i.e. the operations are transparent to the location service support.

5.6 Message flow (single operation example)

This subclause contains examples of message flows for a single transaction consisting of a single operation. These examples may not show all possibilities.

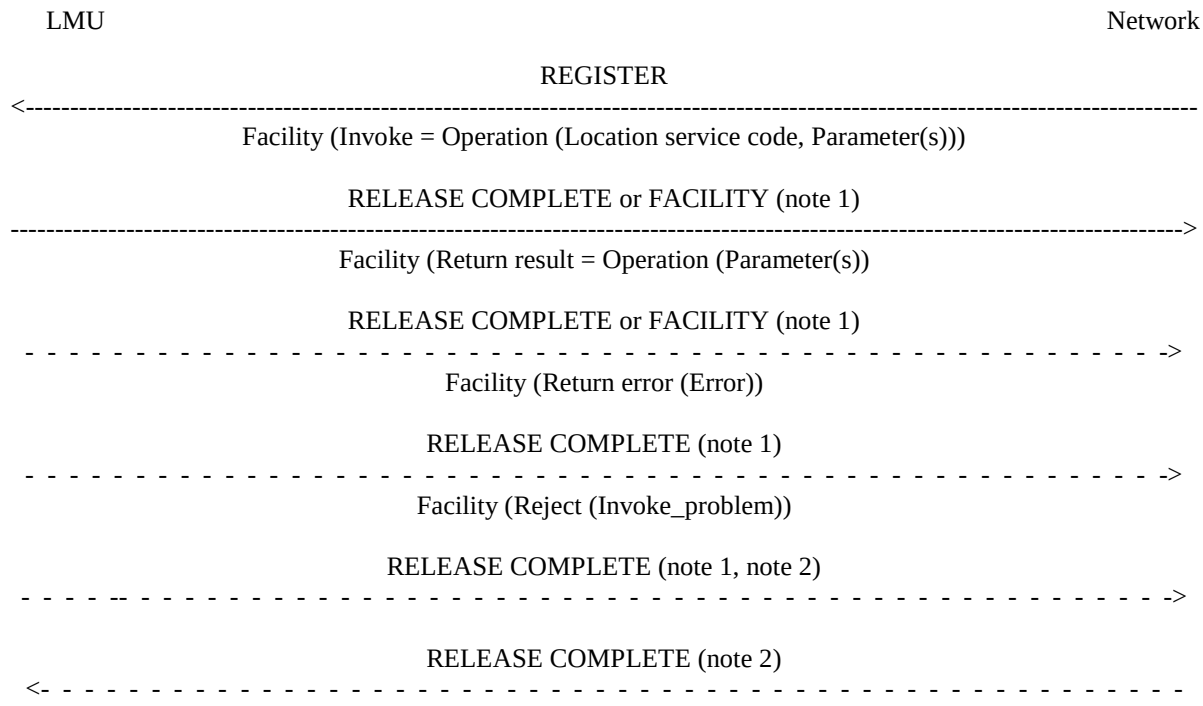
5.6.1 LMU initiated location service transaction



NOTE: To prevent transactions being kept open following exceptional cases, either side of the transaction may release it by sending a RELEASE COMPETE message without a Facility IE.

Figure 3.1: LMU initiated location service transaction

5.6.2 Network initiated location service transaction



NOTE 1: If the network initiated operation does not require a result, reject or error to be returned then the LMU may release the transaction by sending a RELEASE COMPLETE message without a Facility Information Element and release of transaction by LMU is allowed (i.e. Release Forbidden has not been present in Register message). If release is not allowed by LMU, the LMU sends the result using Facility message.

NOTE 2: To prevent transactions being kept open following exceptional cases, either side of the transaction may release it by sending a RELEASE COMPETE message without a Facility IE.

Figure 3.2: Network initiated location service transaction

5.7 Handling of unknown, unforeseen, and erroneous protocol data

5.7.1 General

These procedures only apply to messages where the protocol discriminator is set to indicate LCS operations according to the rules in 3GPP TS 04.07 and this specification. Messages that do not meet this criteria are treated according to other GSM technical specifications.

This subclause specifies procedures for handling of unknown, unforeseen and erroneous protocol data by the receiving entity. The procedures are called "error handling procedures", but they also define a compatibility mechanism for future extension of the protocol.

Most error handling procedures are mandatory in the LMU, but optional in the network. Detailed error handling procedures may vary from PLMN to PLMN.

In this subclause, the following terminology is used:

- An IE is defined to be syntactically incorrect in a message if it contains at least one value defined as "reserved" in this specification or 3GPP TS 04.08. However, it is not a syntactical error if a type 4 IE specifies a length indicator greater than that defined. The component part of the Facility information element is handled by a separate mechanism, and errors in the component part are not covered by this subclause.

The following procedures are listed in order of precedence.

Handling of errors in the contents of the Facility IE is described in subclause 4.2.6, and is outside the scope of this subclause.

5.7.2 Message too short

When a message is received that is too short to contain a complete message type information element, that message shall be ignored.

5.7.3 Unknown or unforeseen transaction identifier

The LMU shall ignore messages with the transaction identifier value set to "111".

If the transaction identifier value is not "111" the following procedures shall apply to the LMU:

a) If a RELEASE COMPLETE message is received specifying a transaction identifier that is not recognized as relating to a LCS transaction that is in progress then the message shall be ignored.

b) If a FACILITY message is received specifying a transaction identifier that is not recognized as relating to a LCS transaction that is in progress then a RELEASE COMPLETE message shall be sent.

c) If a REGISTER message is received specifying a transaction identifier that is not recognized as relating to a LCS transaction that is in progress and with a transaction identifier flag incorrectly set to "1", this message shall be ignored.

The network may follow the same procedures.

5.7.4 Unknown or unforeseen message type

If the LMU receives a message type not defined for the protocol discriminator or not implemented by the receiver, then a RELEASE COMPLETE message shall be sent with cause value #97 "message type non-existent or not implemented".

If the LMU receives a message type not consistent with the transaction state then a RELEASE COMPLETE message shall be sent with cause value #98 "message not compatible with control state".

The network may follow the same procedures.

5.7.5 Non-semantical mandatory Information Element Error

When on receipt of a message:

- an "imperative message part" error; or
- a "missing mandatory IE" error;

is diagnosed, or when a message containing:

- a syntactically incorrect mandatory IE; or
- an IE unknown in the message, but encoded as "comprehension required" (see 3GPP TS 04.08); or
- an out of sequence IE encoded as "comprehension required";

is received, the LMU shall proceed as follows:

a) If the message is not RELEASE COMPLETE it shall send a RELEASE COMPLETE message with cause "#96 - Invalid mandatory information".

b) If the message is RELEASE COMPLETE, it shall be treated as a normal RELEASE COMPLETE message.

The network may follow the same procedures.

5.7.6 Unknown and Unforeseen IEs in the non-imperative part

5.7.6.1 IEIs unknown in the message

The LMU shall ignore all IEs unknown in the message which are not encoded as "comprehension required". The network shall take the same approach.

5.7.6.2 Out of sequence IEs

The LMU shall ignore all out of sequence IEs in a message which are not encoded as "comprehension required".

The network may take the same approach.

5.7.6.3 Repeated IEs

If an information element with format T, TV or TLV (see 3GPP TS 04.07) is repeated in a message in which repetition of the information element is not specified, only the contents of the information element appearing first shall be handled and all subsequent repetitions of the information element shall be ignored. When repetition of information elements is specified, only the contents of specified repeated information elements shall be handled. If the limit on repetition of information elements is exceeded, the contents of information elements appearing first up to the limit of repetitions shall be handled and all subsequent repetitions of the information element shall be ignored.

The network may follow the same procedures.

5.7.7 Non-imperative message part errors

This category includes:

- syntactically incorrect optional IEs;
- conditional IE errors.

Errors in the content of the Facility IE are handled according to subclause 4.2.6.

5.7.7.1 Syntactically incorrect optional IEs (other than Facility)

The LMU shall treat all optional IEs that are syntactically incorrect in a message as not present in the message

The network shall take the same approach.

5.7.7.2 Conditional IE errors

When the LMU upon receipt of a message diagnoses a "missing conditional IE" error, or an "unexpected conditional IE error", or when it receives a message containing at least one syntactically incorrect conditional IE (other than Facility), it shall send a RELEASE COMPLETE message with cause #100 "conditional IE error".

The network may follow the same procedure.

6 Message functional definitions and contents

6.1 General

This clause defines the structure of the messages of the layer 3 protocol defined in 3GPP TS 03.71. These messages are standard L3 messages as defined in 3GPP TS 04.07.

Each definition includes:

a) a brief description of the message;

b) a table listing the information elements in the order of their appearance in the message. In a sequence of consecutive IEs with half octet length, the first IE occupies bits 1 to 4 of octet N, the second bits 5 to 8 of octet N, the third bits 1 to 4 of octet N+1 etc.;

   For each IE the table indicates:

   1) the information element identifier, in hexadecimal notation, if the IE has format T, TV or TLV. If the IEI has half octet length, it is specified by a notation representing the IEI as a hexadecimal digit followed by a "-" (example: B-);

   2) the name of the IE (which gives an idea of the semantics of the element), which is used in this and other specifications as a reference to the IE within the message;

   3) the name of the type of the IE (which indicates the coding of the value part of the IE), and a reference to a description of the value part of the IE;

   4) the presence requirement indication (M, C or O) for the IE, as defined in 3GPP TS 04.07;

   5) the format of the IE (T, V, TV, LV, TLV) as defined in 3GPP TS 04.07;

   6) the length of the IE (or permissible range of lengths), in octets, in the message, where "?" means that the maximum length of the IE is only constrained by the link layer protocol, and in the case of the facility IE by possible further considerations specified in 3GPP TS 03.71. This indication is non-normative.

c) subclauses specifying conditions for IEs with presence requirement C or O in the relevant message. Together with other conditions specified in this specification and 3GPP TS 03.71 defines when the IE shall be included or not, what non-presence of such IEs means, and (for IEs with presence requirement C) the static conditions for presence and/or non-presence of the IEs (see 3GPP TS 04.07).

6.2 Messages for location services control

Table 4.1 summarises the messages for location services control.

The logical DTAP LCS Information Request and DTAP LCS Information Report messages, that are used in LCS Stage 2 (3GPP TS 03.71), are transported using REGISTER, FACILITY and RELEASE COMPLETE messages.

If there exists no LCS transaction between LMU and MSC, REGISTER message is used to deliver the logical message. If LCS transaction between LMU and MSC exists, FACILITY message is used to deliver the logical message. RELEASE COMPLETE message is used to indicate that LCS transaction is not any more needed, LMU can also use this message to transport logical LCS Information Response message.

Table 4.1: Messages for location service control

Messages for location service control	Reference
FACILITY	6.3
REGISTER	6.4
RELEASE COMPLETE	6.5

6.3 Facility

This message is sent by the Location Measurement Unit (LMU) or the network to request or acknowledge a location service. It is used when information is to be conveyed and the transaction already exists, but is not to be released. The location service to be invoked, and its associated parameters, are specified in the Facility information element (see table 4.2). This message contains information transparent to MSC.

Table 4.2: FACILITY message content

IEI	Information element	Type / Reference	Presence	Format	Length
	Location service Protocol discriminator	Protocol discriminator 7.2	M	V	1/2
	Transaction identifier	Transaction identifier 7.3	M	V	1/2
	Facility Message type	Message type 7.4	M	V	1
	Facility	Facility 7.5	M	LV	2-?
90	Release forbidden	Release forbidden 7.6	O	T	1

6.4 Register

6.4.1 Register (network to LMU direction)

This message is sent by the network to the location measurement unit to assign a new transaction identifier for location service control and to request or acknowledge a location service (see table 4.3). This message contains information transparent to MSC.

Table 4.3: REGISTER message content (network to LMU direction)

IEI	Information element	Type / Reference	Presence	Format	Length
	Location service Protocol discriminator	Protocol discriminator 7.2	M	V	1/2
	Transaction identifier	Transaction identifier 7.3	M	V	1/2
	Register Message Type	Message type 7.4	M	V	1
	Facility	Facility 7.5	M	LV	2-?
90	Release forbidden	Release forbidden 7.6	O	T	1

6.4.2 Register (LMU to network direction)

This message is sent by the location measurement unit to the network to assign a new transaction identifier for location service control and to request or acknowledge a location service (see table 4.4). This message contains information transparent to MSC.

Table 4.4: REGISTER message content (LMU to network direction)

IEI	Information element	Type / Reference	Presence	Format	Length
	Location service Protocol discriminator	Protocol discriminator 7.2	M	V	1/2
	Transaction identifier	Transaction identifier 7.3	M	V	1/2
	Register Message type	Message type 7.4	M	V	1
	Facility	Facility 7.5	M	LV	2-?

6.5 Release complete

This message is sent by the location measurement unit or the network to release a transaction used for location service control. It may also request or acknowledge a location service (see table 4.5). This message contains information transparent to MSC.

Table 4.5: RELEASE COMPLETE message content

IEI	Information element	Type / Reference	Presence	Format	Length
	Location service Protocol discriminator	Protocol discriminator 7.2	M	V	1/2
	Transaction identifier	Transaction identifier 7.3	M	V	1/2
	Release Complete Message type	Message type 7.4	M	V	1
10	Cause	Cause 3GPP TS 04.08	O	TLV	4-32
11	Facility	Facility 7.5	O	TLV	2-?

6.5.1 Cause

This information element shall be included when the functional handling of the Cause IE is specified in the service description. If the functional handling of the Cause IE is not specified, the receiving entity may ignore the IE. The Cause IE used in location services is defined in 3GPP TS 04.08 in Clause 10.5.4.11 (only applicable Cause values are used).

6.5.2 Facility

This information element shall be included as required by the service description and the procedures defined in this specification and in 3GPP TS 03.71.

7 General message format and information elements coding between LMU and MSC

The figures and text in this clause describe message contents. Within each octet, the bit designated "bit 1" is transmitted first, followed by bits 2, 3, 4, etc. Similarly, the octet shown at the top of each figure is sent first.

7.1 Overview

Within the layer 3 protocol defined in this specification, every message is a standard L3 message as defined in 3GPP TS 04.07. This means that the message consists of the following parts:

a) protocol discriminator;

b) transaction identifier;

c) message type;

d) other information elements, as required.

Unless specified otherwise, a particular information element may be present only once in a given message.

When a field extends over more than one octet, the order of bit values progressively decreases as the octet number increases. The least significant bit of the field is represented by the lowest numbered bit of the highest numbered octet of the field.

7.2 Protocol discriminator

The Protocol Discriminator (PD) and its use are defined in 3GPP TS 04.07. This specification defines the protocols relating to the PD values:

1 1 0 0 location services

7.3 Transaction identifier

For general rules, format and coding of transaction identifier values, see 3GPP TS 04.08.

7.4 Message type

The message type IE and its use are defined in 3GPP TS 04.07. Table 5.1 defines the value part of the message type IE used in the location service protocol.

Table 5.1: Message types

8	7	6	5	4	3	2	1	Message types
0	X	1	0	.	.	.	.	Clearing messages:
				0	0	0	1	- RELEASE COMPLETE
0	X	1	1	.	.	.	.	Miscellaneous message group:
				0	0	0	1	- FACILITY
				0	0	1	0	- REGISTER
NOTE 1: Bit 8 is reserved for possible future use as an extension bit, see 3GPP TS 04.07.								
NOTE 2: Bit 7 is reserved for the send sequence number in messages sent from the mobile station. In messages sent from the network, bit 7 is coded with a "0", see 3GPP TS 04.07.								

7.5 Facility information element

The purpose of the Facility information element is to indicate the invocation and operation of location services, identified by the corresponding operation code within the Facility information element.

The Facility information element is coded as shown in figure 5.1 and clause 8.

The Facility is a type 4 information element with no upper length limit except that given by the maximum number of octets in a L3 message, see 3GPP TS 04.06.

8	7	6	5	4	3	2	1	
Facility IEI								octet 1
Length of Facility contents								octet 2
Component(s) (note)								octet 3 etc.
NOTE: This component contains Transparent LCS Information. Encoding of this component is according to clause 8.								

Figure 5.1: Facility information element

7.6 Release forbidden

This information element is used only in MSC to LMU messages. The presence of IE indicates that the release of LCS transaction is not allowed by LMU.

8 General message format and information elements coding between LMU and SMLC

8.1 Transparent LCS Information

This clause provides the formats and encoding of Transparent LCS Information component in the Facility information element. The contents of this component is copied directly from Signal Info from MAP message (see the clause 6.1.4). Formats and encoding methods make use of and is a subset of ITU-T Recommendation Q.773 (Transaction Capabilities formats and Encoding) and T/S 43/BB. The used part of ITU-T Recommendation Q.773 respectively T/S 43/BB is almost the same as the Component Portion of TC messages.

This subclause is further based on:

- Abstract Syntax Notation One (ASN.1) “Specification of Basic Notation” ITU-T Rec.X.680 (1997) | ISO/IEC 8824 – 1:1998
- ASN.1 encoding rules “Specification of Packet Encoding Rules (PER)” ITU-T Rec. X.691 (1997) | ISO/IEC 8825-2:1998

and is consistent with these ITU-Trecommendations. BASIC-PER, unaligned variant is used.

NOTE: Concerning the general rules for encoding (structure of encoding, identifier octets, length octets, etc.) see CCITT Recommendations X.208 and ITU-T Recommendation X.691. For these general rules the same exceptions apply as stated in 3GPP TS 09.02. Following ASN.1 definitions are exactly same than in ITU-T Recommendation Q.773.

NOTE: invokeNotLast component is added to the Component list. This change impacts to the coding of the Component type and thus to coding of the LLP messages.

The Component portion of the TCAP used in this protocol. LLP, is a modification of the TCAP Component portion defined in ITU-T Recommendation, Q.773.

```
Component ::=   CHOICE {
    invoke                  [1] IMPLICIT Invoke,
    returnResultLast        [2] IMPLICIT ReturnResult,
    returnError             [3] IMPLICIT ReturnError,
    reject                  [4] IMPLICIT Reject,
    returnResultNotLast     [7] IMPLICIT ReturnResult,
    invokeNotLast           [8] IMPLICIT Invoke }

-- The Components are sequences of data elements.

Invoke ::=      SEQUENCE {
    invokeID                InvokeIdType,
    linkedID                [0] IMPLICIT InvokeIdType OPTIONAL,
    operationCode           OPERATION,
    parameter               ANY DEFINED BY operationCode OPTIONAL }

-- ANY is filled by the single ASN.1 data type following the keyword PARAMETER or the keyword
ARGUMENT
-- in the type definition of a particular operation.

ReturnResult ::=    SEQUENCE {
    invokeID                InvokeIdType,
    result              SEQUENCE {
    operationCode           OPERATION,
    parameter               ANY DEFINED BY operationCode
    } OPTIONAL
    }

-- ANY is filled by the single ASN.1 data type following the keyword RESULT in the type definition
-- of a particular operation.

ReturnError ::= SEQUENCE {
    invokeID                InvokeIdType,
    errorCode               ERROR,
    parameter               ANY DEFINED BY errorCode OPTIONAL }

-- ANY is filled by the single ASN.1 data type following the keyword PARAMETER in the type
definition
-- of a particular error.

Reject ::=      SEQUENCE {
    invokeID CHOICE {
        derivable           InvokeIdType,
        not-derivable           NULL },
    problem CHOICE {
        generalProblem      [0] IMPLICIT GeneralProblem,
        invokeProblem       [1] IMPLICIT InvokeProblem,
        returnResultProblem     [2] IMPLICIT ReturnResultProblem,
        returnErrorProblem      [3] IMPLICIT ReturnErrorProblem} }

InvokeIdType ::=    INTEGER (–128..127)
```

8.1.1 Operation Code

Each Operation is assigned an Operation Code to identify it. The Operation Codes for the different Operations are defined in subclause 9.2.

8.1.2 Error Code

Each Error is assigned a value (Error Code) to identify it. The Error Codes for the different Errors are defined in subclause 7.3.

8.1.3 Problem Code

The Problem Code consists of one of the four elements: General Problem, Invoke Problem, Return Result Problem or Return Error Problem. ASN.1 definitions are presented below.

```
-- PROBLEMS

GeneralProblem      ::= INTEGER {       unrecognizedComponent (0),
                                mistypedComponent (1),
                                badlyStructuredComponent (2) }

InvokeProblem       ::= INTEGER {       duplicateInvokeID (0),
                                unrecognizedOperation (1),
                                mistypedParameter (2),
                                resourceLimitation (3),
                                initiatingRelease (4),
                                unrecognizedLinkedID (5),
                                linkedResponseUnexpected (6),
                                unexpectedLinkedOperation (7) }

ReturnResultProblem ::= INTEGER {       unrecognizedInvokeID (0),
                                returnResultUnexpected (1),
                                mistypedParameter (2) }

ReturnErrorProblem  ::= INTEGER {       unrecognizedInvokeID (0),
                                returnErrorUnexpected (1),
                                unrecognizedError (2),
                                unexpectedError (3),
                                mistypedParameter (4) }
```

9 LMU LCS Protocol operation specifications

9.1 General

This clause specifies the abstract syntax for the LMU LCS Protocol using the Abstract Syntax Notation One (ASN.1), defined in CCITT Recommendation X.680 (1997).

The encoding rules which are applicable to the defined abstract syntax are the Packet Encoding Rules for Abstract Syntax Notation One, defined in ITU-T Recommendation X.691. For each Location Service parameter which has to be transferred by a Location Service message, there is a PDU field (an ASN.1 NamedType) whose ASN.1 identifier has the same name as the corresponding parameter, except for the differences required by the ASN.1 notation (blanks between words are removed, the first letter of the first word is lower-case and the first letter of the following words are capitalized (e.g. "bearer service" is mapped to "bearerService"). In addition some words may be abbreviated as follows:

lmu: location measurement unit;

lcs: location services;

The ASN.1 data type which follows the keywords ARGUMENT "PARAMETER" or "RESULT" (for OPERATION and ERROR) is always optional from a syntactic point of view. However, except specific mention, it has to be considered as mandatory from a semantic point of view. When in an invoke component, a mandatory element is missing in any component or inner data structure, a reject component is returned with the problem code "Mistyped Parameter". When an optional element is missing in an invoke component or in an inner data structure while it is required by the context, an error component is returned; the associated type of error is "DataMissing".

In case an element is defined as mandatory in the protocol description (3GPP TS 04.71 including imports from 3GPP TS 09.02), but is not present according to the service description (stage 1 to stage 3), the ASN.1 protocol description takes precedence over the diagrams in the 3GPP TS 04.8x and 04.9x-series of technical specifications.

When possible operations and errors are imported from 3GPP TS 09.02 thereby making the MSC transparent to most of the messages sent to or from the LMU.

Timer values for operations which require timers are shown as ASN.1 comments.

Ellipsis Notation shall be used in the same way as described in 3GPP TS 09.02 and shall be supported on the radio interface by the LMU and the network for all operations defined in this specification including those imported from 3GPP TS 09.02.

9.2 Operation types

Table 7.1 summarizes the operations defined for LMU LCS Protocol in this specification, and shows which of these operations are Radio Interface Timing (RIT) related, Time Of Arrival (TOA) location method related, and general LMU procedures related. In this ASN.1 module, ASN.1/88 defined in CCITT X.680 recommendations (ASN.1 1997) is used.

Table 7.1: Relevance of location service operations

Operation name	Direction	Response allowed	RIT	TOA	General LMU
StartRIT	SMLC -> LMU	ReturnResult (empty) .	X		
ReportRIT	LMU -> SMLC	No	X		
StopRIT	SMLC -> LMU	ReturnResult (empty).	X		
IndicateRITError	LMU -> SMLC	No	X		
PerformTOA	SMLC -> LMU	ReturnResult		X	
StatusQuery	SMLC -> LMU	ReturnResult			X
StatusUpdate	LMU -> SMLC	ReturnResult (empty)			X
ResetRequest	SMLC -> LMU	ReturnResult (empty).			X
OMMngrRequest	SMLC -> LMU	ReturnResult			X
OMAgntRequest	LMU -> SMLC	ReturnResult			X

This specification defines the following operations (transparent to MSC):

- StartRIT
- ReportRIT
- StopRIT
- IndicateRITError
- PerformTOA
- StatusQuery
- StatusUpdate
- ResetRequest
- OMMngrRequest
- OMAgntRequest

```
-- LLP-Operations module defines the operations transparent to MSC

LLP-Operations
-- { LLP-Operations object identifier }

DEFINITIONS ::=

BEGIN


IMPORTS
    OPERATION
FROM TCAPMessages {
```

```
   ccitt recommendation q 773 modules (2) messages (1) version2 (2)}

SystemFailure,
    DataMissing,
    UnexpectedDataValue,
    FacilityNotSupported,
    UnknownSubscriber,
FROM MAP-Errors {
   ccitt identified-organization (4) etsi (0) mobileDomain (0)
   gsm-Network (1) modules (3) map-Errors (10) version4 (4)}


    UnDefinedError
FROM LLP-Errors
-- {}

    StartRITReq,
    StartRITRsp,
    ReportRITArg,
    StopRITReq,
    StopRITRsp,
    ErrorRITArg,
    PerformTOAReq,
    TOAResultRsp,
    StatusReq,
    StatusRsp,
    ResetReq,
    ResetRsp,
    StatusUpdateReq,
    StatusUpdateRsp
FROM LLP-DataTypes {
   ccitt identified-organization (4) etsi (0) mobileDomain (0)
   gsm-Network (1) modules (3) map-LCS-DataTypes (n) version4 (4)}

    OMMngrReq,
    OMMngrRsp,
    OMAgntReq,
    OMAgntRsp,
    NACKCauses
FROM LLP-OM-Protocol --{ LLP-OM-Protocol Object identifier }--
;

-- OPERATION definitions based on macro notation

StartRIT::= OPERATION       -- identifier StartRIT-Measurement
    ARGUMENT
        startRITReq     StartRITReq
RESULT
        startRITRsp     StartRITRsp
    ERROR {

    SystemFailure,
    DataMissing,
    UnexpectedDataValue,
    ResourcesNotAvailable,
    UnDefinedError
    }

ReportRIT::= OPERATION      -- identifier ReportRIT-Measurement
    ARGUMENT
        reportRITArg        ReportRITArgR

StopRIT::= OPERATION        -- identifier StopRIT-Measurement

    ARGUMENT
        stopRITReq      StopRITReq
    RESULT
        StopRITRsp      StopRITRsp

IndicateRITError ::= OPERATION
    ARGUMENT
        errorRITArg     ErrorRITArg
```

```
PerformTOA::= OPERATION      -- identifier PerformTOA-Measurment
    ARGUMENT
        performTOAReq        PerformTOAReq
RESULT
        toaResultRsp         TOAResultRsp
    ERROR {
    SystemFailure,
    DataMissing,
    UnexpectedDataValue,
    ResourcesNotAvailable,
    UnDefinedError
    }
```

```
StatusQuery::= OPERATION
    ARGUMENT
        statusReq            StatusReq
    RESULT
        statusRsp            StatusRsp
    ERROR {
    }
```

```
ResetRequest::= OPERATION
    ARGUMENT
        resetReq             ResetReq
    RESULT
        resetRsp             ResetRsp
    ERROR {
    SystemFailure,
    UnDefinedError
    }
```

```
OMMngrRequest ::= OPERATION          -- defined in LLP-OM, 12.71
    ARGURMENT
        oMMngrReq   OMMngrReq
    RESULT
        oMMngrRsp   OMMngrRsp
    ERROR
    {
    NACKCauses
    }
```

```
OMAgntRequest   ::= OPERATION        -- defined in LLP-OM, 12.71
    ARGURMENT
        oMAgntReq   OMAgntReq
    RESULT
        oMAgntRsp   OMAgntRsp
        ERROR
    {
        NACKCauses
    }
```

```
StatusUpdate ::= OPERATION       -- identifier Status Update
    ARGUMENT
        statusUpdateReq          StatusUpdateReq
    RESULT
        statusUpdateRsp          StatusUpdateRsp
    ERROR {
    SystemFailure,
    DataMissing,
    UnexpectedDataValue,
    ResourceNotAvailable,
    UnDefinedError
}
```

```
END
```

9.2.1 Operation types description

For each operation type this subclause provides a brief prose description.

9.2.1.1 StartRIT (network --> LMU)

This operation type is invoked by the network to request RIT measurement information from an LMU.

9.2.1.2 ReportRIT (LMU -->network)

This operation type is invoked by an LMU to report to the network RIT measurement information. This operation is used to report periodical measurements.

9.2.1.3 StopRIT (network --> LMU)

This operation type is invoked by the network to request an LMU to stop on-going RIT measurements and reporting.

9.2.1.4 IndicateRITError (LMU --> network)

This operation type is invoked by an LMU to indicate error situations.

9.2.1.5 PerformTOA (network --> LMU)

This operation type is invoked by the network to request an LMU to perform TOA location mesurements. The measurement results are returned using the return result component of the operation.

9.2.1.6 StatusQuery (network --> LMU)

This operation type is invoked by the network to request status an LMU The status is returned using the return result component of the operation.

9.2.1.7 StatusUpdate (LMU --> network)

This operation type is invoked by an LMU to report status of LMU, e.g. after reset or periodically.

9.2.1.8 ResetRequest (network --> LMU)

This operation type is invoked by the network to reset an LMU.

9.2.1.9 OMMngrRequest (network --> LMU)

This operation type is invoked by the network to request a specific O&M activity to LMU as defined in 3GPP TS 12.71.

9.2.1.10 OMAgntRequest (LMU -> network)

This operation type is invoked by the LMU to report an O&M event to Network or asking for reporting O&M information from Network as defined in 3GPP TS 12.71.

10.3 Error types

10.3.1 Error types ASN.1 specification

The following ASN.1 module provides an ASN.1 specification of errors. Errors from MAP are imported in the LCS-Protocol module in subclause 9.2. In this ASN.1 module, ASN.1/88 defined in CCITT X.680 recommendations (ASN.1 1997) is used.

```
LLP-Errors
-- { LLP-Errors object identifier }

DEFINITIONS ::=

BEGIN

IMPORTS

ERROR FROM
TCAPMessages FROM {
    ccitt recommendation q 773 modules (2) messages (1) version2 (2) }
;

-- The MAP errors

-- error types definition
UnDefinedError ::=ERROR

END
```

10.3.2 Error types description

For each error type this subclause provides a brief prose description.

10.3.2.4 SystemFailure

This error is returned by the LMU or the network, when it cannot perform an operation because of a failure.

10.3.2.5 DataMissing

This error is returned by the network or the LMU when an optional parameter is missing in an invoke component or an inner data structure, while it is required by the context of the request.

10.3.2.6 UnexpectedDataValue

This error is returned by the network or the LMU when it receives a parameter with an unexpected value, without type violation.

10.3.2.7 ResourcesNotAvailable

This error is returned by the network or the LMU if temporarily there are no resources.

10.3.2.9 UnDefinedError

This error is returned by the LMU or the network when any other error type is not applicable.

10.4 Operations and errors implementation

For the actual implementation of location services, operations and errors have to be defined by value. The following ASN.1 module, imports operation types from the ASN.1 module described in subclause 9.2 and operation and error types from MAP. It defines operations by allocating operations and errors a local value. For the involved operations and errors the same local values as in MAP are allocated. In this ASN.1 module, ASN.1/88 defined in CCITT X.680 recommendations (ASN.1 1997) is used.

```
LLP-Protocol
-- { LLP-Protocol object identifier }

DEFINITIONS ::=

BEGIN

IMPORTS

SystemFailure,
    DataMissing,
    UnexpectedDataValue,
    FacilityNotSupported,
    UnknownSubscriber,
FROM MAP-Errors {
   ccitt identified-organization (4) etsi (0) mobileDomain (0)
   gsm-Network (1) modules (3) map-Errors (10) version4 (4)}


    UnDefinedError
FROM LLP-Errors
-- { LLP-Errors object identifier }

StartRIT,
    ReportRIT,
    StopRIT,
IndicateRITError,
    PerformTOA,
    StatusQuery,
    ResetRequest,
    OMRequest,
    OMReport,
    StatusUpdate
FROM -LLP-Operations
-- { LLP-Operations object identifier }
-- allocate local values for errors

systemFailure   SystemFailure ::= localValue 10
dataMissing     DataMissing ::= localValue 11
unexpectedDataValue UnexpectedDataValue ::= localValue 12
facilityNotSupported    FacilityNotSupported ::= localValue 13
unknownSubscriber       UnknownSubscriber ::= localValue 14
unDefinedError  UnDefinedError ::= localValue 50

startRIT    StartRIT ::= localValue 10
reportRIT   ReportRIT ::= localValue 11
stopRIT StopRIT ::= localValue 12
indicateRITError    IndicateRITError ::= localValue 13
performTOA  PerformTOA ::= localValue 20
statusQuery statusQuery ::= localValue 30
resetRequest    ResetRequest ::= localValue 31
omMngrRequest   OMMngrRequest ::= LocalValue 32
omAgntRequest   OMAgntRequest ::= LocalValue 33
StatusUpdate    StatusUpdate ::= LocalValue 34

END
```

11 LMU LCS Protocol (LLP) messages

11.1 Messages, data types and identifiers

11.1.1 General

This clause defines the External Signal Info IE, that contains Signal Info string. Signal Info string contains the MLC-LMU messages defined by ASN.1 and coded by PER (X.691). In this ASN.1 module, ASN.1/94 defined in ITU-T X.680 recommendations (ASN.1 1997) is used.

11.1.2 ASN.1 data types

```
LLP-DataTypes
-- { LLP-DataTypes object identifier }

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS

ExtensionContainer

FROM MAP-ExtensionDataTypes {

   ccitt identified-organization (4) etsi (0) mobileDomain (0)

   gsm-Network (1) modules (3) map-ExtensionDataTypes (21) version4 (4)}



;


StartRITReq ::= SEQUENCE {
    rit-MeasurementType     RIT-MeasurementType,
    rit-ReportingType           RIT-ReportingType,
    rit-Environment         RIT-Environment,
    rit-NeigborNumber           RIT-NeighborNumber,
    rit-NeighborType            RIT-NeighborType,
    rit-CIMethod            CIMethod,
    rit-BTSInfo             RIT-BTSInfo         OPTIONAL,
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}
StartRITRsp ::= SEQUENCE {
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}

StopRITReq ::= SEQUENCE {
extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}

StopRITRsp ::= SEQUENCE {
extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}

ReportRITArg ::= SEQUENCE {
    rit-ReferenceIDInfo     RIT-ReferenceIDInfo,
    rit-ResponseInfo        SeqOfRIT-ResponseInfo,
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}

StatusReq ::= SEQUENCE {
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}
```

```
StatusRsp ::= SEQUENCE {
    statusTime              StatusTime,
    rit-Status              RIT-Status,
    toa-Status              TOA-Status,
    omStatus                OMStatus,
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}

ErrorRITArg ::= SEQUENCE {
    rit-ErrorType           RIT-ErrorType,
    rit-ErrorReason         RIT-ErrorReason,
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
    }

PerformTOA ::= SEQUENCE {
    toa-MeasurementDeviceInfo   TOA-MeasurementDeviceInfo,
    toa-ChannelDescr            TOA-ChannelDescr,
    toa-SignalDescr         TOA-SignalDescr,
    toa-TimingDescr         TOA-TimingDescr,
    toa-MeasurementOpt      TOA-MeasurementOpt  OPTIONAL,
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}



TOAResultRsp ::= SEQUENCE {
    toa-TimingReferenceInfo     TOA-TimingReferenceInfo,
    toa-Measurements            TOA-MeasurementInfo,
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}

StatusUpdateReq ::= SEQUENCE {
    statusReason                StatusReason,
    statusTime                  StatusTime,
    ritStatus                   RIT-Status,
    toaStatus                   TOA-Status,
    omStatus                        OMStatus,
    extensionContainer      ExtensionContainer  OPTIONAL,
…
}

StatusUpdateRsp ::= SEQUENCE {
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}

ResetReq ::= SEQUENCE {
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}

ResetRsp ::= SEQUENCE {
    extensionContainer      ExtensionContainer  OPTIONAL,
    ...
}


-- DATA TYPES DEFINITION

-- RIT measurement Type information
RIT-MeasurementType ::= INTEGER {
    atdMeasure (0),
    atdOrOtdMeasure (1),
    rtdMeasure (2)
} (0..7)

-- RIT Reporting Type information
RIT-ReportingType ::= SEQUENCE {
    rit-ReportingPeriodInfo     RIT-ReportingPeriodInfo OPTIONAL,
    rit-ChangeLimit         INTEGER (1..255)            OPTIONAL,
    rit-DeviationLimit          INTEGER (1..255)            OPTIONAL,
    rit-MonitorPeriod           INTEGER (1..64)             OPTIONAL
}
```

```
RIT-ReportingPeriodInfo ::= SEQUENCE {
    rit-ReportingPeriodFormat   ENUMERATED {
                                    tensOfSeconds (0),
                                    tensOfMinutes (1) },
    rit-ReportingPeriod     INTEGER (1..120)
}


-- RIT Environment Information
RIT-Environment ::= INTEGER {
    heavyMultiPathAndNLOS (0),
        -- bad urban or urban heavy multipath and NLOS conditions
    lightMultiPathAndLOS (1),
        -- suburban or rural ligth multipath and LOS conditions
    mixedEnvironement (2)
        -- not defined or mixed environment

} (0..7)


RIT-NeighborNumber ::= INTEGER (0..15)

RIT-NeighborType ::= INTEGER {
    listedNeighbors (0),
    listedAndSystemInfo2or5 (1),
    systemInfoType2or5 (2),
    allNeighbors (3)
} (0..7)

CIMethod ::= INTEGER {
    notCi (0),  -- report ci and carrier instead of CI
    ci (1)      -- report CI if possible
} (0..3)

-- element contains information of base stations
-- to be measured
RIT-BTSInfo ::= SEQUENCE (SIZE(1..31)) OF RIT-BTSList   -- list of btss

RIT-BTSList ::= SEQUENCE {
    rit-ListCi      CI,
    rit-TimeSlotScheme      TimeSlotScheme,
    rit-ListBSIC            BSIC,
    rit-ListBCCHCarrier     BCCHCarrier
}

CI ::= INTEGER (0..65535)

TimeSlotScheme ::= INTEGER {
    schemeUnknown (0),
    equalLength     (1),    -- time slots are equal length
    variousLength (2)       -- the first time slot is 157b
} (0..7)

BSIC ::= INTEGER (0..63)

BCCHCarrier ::= INTEGER (0..1023)

RIT-ReferenceIDInfo ::= SEQUENCE {
    rit-ReferenceLAC            LAC,            -- defined earlier
    rit-ReferenceCI         CI,         -- defined earlier
    rit-ReferenceFrameNbr       FrameNumber,    -- defined earlier

    -- If rit-ATReference is absent then there is not RIT AT refernce value.
    rit-ATReference             RIT-ATReference     OPTIONAL,

    rit-ReferenceTimeSlot       TimeSlot,       -- defined earlier
    rit-ReferenceRXLevel        RXLevel,        -- defined earlier
    rit-ATDRTDQualityRes        INTEGER (0..3), -- defines the resolution for ATDRTD values
    rit-ATDRTDChangeQualityRes  INTEGER (0..3)  -- defines the resolution for ATDRTD change values
}

RIT-NoATReference ::= NULL

RIT-ATReference ::= SEQUENCE {
    rit-CommonClock         CommonClock,
    rit-ReferenceATValue        ReferenceATValue,
    -- This Quality information defines the quality of AT value
```

```
    -- Resolution defines the resolution of Quality field as follows,
    -- 0= 0.005 us, 1= 0.01 us, 2= 0.05 us
    rit-RefATQuality        SEQUENCE {
                                resolution      INTEGER (0..3),
                                atQuality       INTEGER (0..63) },
    rit-ReferenceATChange       INTEGER (-1000 .. 1000),

    -- This Quality information defines the quality of ATChange value
    -- Resolution defines the resolution of Quality field as follows,
    -- 0= 0.00005 ppm, 1= 0.0001 ppm, 2= 0.0005
    rit-RefATChangeQuality  SEQUENCE {
                                resolution      INTEGER (0..3),
                                atChangeQuality INTEGER (0..63) }
}

-- Editor's note: ReferenceATValue was divided in two parts because 15 999 999 999 requires 34 bits.
-- In order to handle 34-bits values, LMU should support 64-bits calculation, which can cause
problems.
-- This solution can be handled with 32-bits and in addition it gives better resolution.
ReferenceATValue ::= SEQUENCE {
    seconds     INTEGER (0..59),
    nsecods     INTEGER (0..999999999)
}

SeqOfRIT-ResponseInfo ::= SEQUENCE (SIZE (1..15)) OF RIT-ResponseInfo

-- Measured RTD values from one neighbor
RIT-ResponseInfo ::= SEQUENCE {

    rit-NeighborCellIDInfo      RIT-CellIDInfo,
    rit-NeighborTimeSlot        TimeSlot,
    rit-NeighborRxLevel     RXLevel,
    rit-NeighborFrameNumber     FrameNumber     OPTIONAL,
    rit-NeighborATDRTD              INTEGER (0..923200),
    rit-NeighborATDRTDQuality       INTEGER (0..63),
    rit-NeighborATDRTDChange        INTEGER (-2000..2000),
}

RIT-CellIDInfo ::= CHOICE {
    rit-NeighborCI          CI,
    rit-NeighborBTS         RIT-NeighborBTS
}

RIT-NeighborBTS ::= SEQUENCE {
    rit-NeighborBSIC            BSIC,
    rit-NeighborBCCHCarrier     BCCHCarrier
}

FrameNumber ::= INTEGER (0..2715647)

LAC ::= INTEGER (0..65535)

CommonClock ::= INTEGER {
    gpsClock    (0),
    glonass     (1)
} (0..7)

TimeSlot ::= INTEGER (0..7)

RXLevel ::= INTEGER (0..63) -- range -150 to -24 with 2dBm steps

-- STATUS ELEMENTS

StatusReason ::= ENUMERATED {
    powerUp (0),                -- no knowledge about previous states
    unsucSWReset (1),           -- unsuccessful recovery
    sucSWReset (2),         -- successful recovery
    unknownError (3),           -- unknown selfdiagnosis error
unrelTBError (4),           -- unreliable timebase error
    periodicReport (5),     -- periodic status report
   …
}

StatusTime ::= SEQUENCE {
    referenceLAC            LAC,        -- defined earlier
    referenceCI             CI,     -- defined earlier
    referenceFrameNumber        FrameNumber -- defined earlier
}
```

```
RIT-Status ::= INTEGER (0..63)  -- defines the number of RIT-Jobs

TOA-Status ::= INTEGER (0..63)  -- defines the number of TOA-Jobs

OMStatus ::= INTEGER (0..63)    -- defines the number of OM-Jobs
-- ERROR RIT ELEMENTS

RIT-ErrorType ::= INTEGER {
    permament (0),
    temporary (1)
} (0..3)

RIT-ErrorReason ::= INTEGER {


    noNeighbors (0),
    noReferenceClock (1),
    notSupportedType (2),
    undefinedError (3)
} (0..15)


-- TOA DEFINITIONS

-- MEASUREMENTDEVICE INFORMATION
TOA-MeasurementDeviceInfo ::= SEQUENCE (SIZE(1..6)) OF TOA-LMUMeasurementDevice
    -- list of measurement devices

TOA-LMUMeasurementDevice ::= INTEGER (0..5)


-- CHANNEL DESCRIPTION
TOA-ChannelDescr ::= SEQUENCE {
    toa-FrequencyListType       TOA-FrequencyListType,
    toa-hopping         TOA-Hopping   OPTIONAL,
    toa-channelType         TOA-ChannelType,
    toa-numberOfBursts      TOA-NumberOfBurst
}

TOA-FrequencyListType ::= CHOICE {
    frequencyListOnly           FrequencyListOnly,
    frequencyListAndIndex       FrequencyListAndIndex,
    frequencyIndexOnly      FrequencyIndexOnly
}

FrequencyListOnly ::= SEQUENCE (SIZE(1..64)) OF TOA-ARFCNumber
    -- list of channels


FrequencyListAndIndex ::= SEQUENCE {
    toa-arfcnList               TOA-ARFCList,
                    -- list of channels
    frequencyIndex          FrequencyIndex
}

TOA-ARFCList ::= SEQUENCE (SIZE(1..64)) OF TOA-ARFCNumber

FrequencyIndexOnly ::= SEQUENCE {
    frequencyIndex          FrequencyIndex
}

FrequencyIndex ::= INTEGER (0..31)


TOA-ARFCNumber ::= BCCHCarrier  -- defined earlier


TOA-Hopping ::= SEQUENCE {
    toa-maio                MAIO,
    toa-hsn             HSN,
    toa-MsframeNumber       ModuloFrameNumber
}

MAIO ::= INTEGER (0..63) -- Mobile Allocation Index Offset

HSN ::= INTEGER (0..63) -- Hopping Sequence Number
```

```
ModuloFrameNumber ::= INTEGER (0..84863)

TOA-ChannelType ::= INTEGER {
    tchf(0),


    tchhscn0 (1),
    tchhscn1 (2)
} (0..7)

TOA-NumberOfBurst ::= INTEGER (0..7)


-- SIGNAL DESCRIPTION
TOA-SignalDescr ::= SEQUENCE {
    toa-BurstType           TOA-BurstType
}

TOA-BurstType ::= CHOICE {
    toa-AccessBurst         TOA-AccessBurst,    -- access burst
    toa-TSC             TSC         -- normal burst
}

TOA-AccessBurst ::= SEQUENCE {
    toa-HOReference         HOReference,
    toa-BSIC                BSIC    -- defined earlier
}

HOReference ::= INTEGER (0..255)

TSC ::= INTEGER (0..7)


-- TIMING DESCRIPTION

TOA-TimingDescr ::= SEQUENCE {
    toa-TimeReference           TOA-TimeReference,
    toa-timeUncertainty     TimeUncertainty
}

TOA-TimeReference ::= CHOICE {
    toa-gpsTime             TOA-GPSTime,
    toa-gsmStartTime            TOA-GSMStartTime
}

TOA-GPSTime ::= SEQUENCE {
    toa-GPSStartTime            GPSStartTime,
    toa-GPSSV               GPSSV

}

GPSStartTime ::= INTEGER (0..14999999) -- unit is microseconds

GPSSV ::= INTEGER (0..31)

TOA-GSMStartTime ::= SEQUENCE {
    toa-arfcn               BCCHCarrier,    -- defined earlier
    toa-bsic                BSIC,       -- defined earlier
    toa-GSMStartTime    GSMTime
}

GSMTime ::= SEQUENCE {
    toa-GSMTimeframeNumber      GSMTimeFrameNumber,
    toa-timeSlot            TimeSlot,
    toa-bitNumber           BitNumber
}

GSMTimeFrameNumber ::= INTEGER (0..42323)

BitNumber ::= INTEGER (0..156)

TimeUncertainty ::= INTEGER (0..15)


-- MEASUREMENT OPTIONS

TOA-MeasurementOpt   ::= SEQUENCE {
```

```
    toa-LMUMethod           TOA-Method,
    toa-Environment         TOA-Environment,
    toa-MeasurementType     TOA-MeasurementType
}

TOA-Method ::= INTEGER (0..7)

TOA-Environment ::= INTEGER {
    heavyMpathAndNLOS (0),
    lightMpathAndLOS (1),
    mixed (2)
} (0..7)

TOA-MeasurementType ::= INTEGER {
    reportTOA-only (0),
    reportAOA-only (1),
    reportTOAandAOA (2)
} (0..3)


-- TIMING INFO

TOA-TimingReferenceInfo ::= CHOICE {
    toa-GPSTimeInfo         NULL,
    toa-GSMTimeInfo         TOA-GSMTimeInfo
}

TOA-GSMTimeInfo ::= SEQUENCE {
    toa-bcch                BCCHCarrier,    -- defined earlier
    toa-bsic                BSIC        -- defined earlier
}


-- THE ACTUAL TOA MEASUREMENTS

TOA-MeasurementInfo ::= SEQUENCE (SIZE(1..6)) OF TOA-Measurements
        -- list of measurementDevices

TOA-Measurements    ::= SEQUENCE {
    toa-MeasurementDeviceID     MeasurementDeviceID,
    toa-AddMeasurementInfo      TOA-AddMeasurementInfo,
    toa-measuredPeakList        TOA-MeasuredPeakList
}


-- MEASUREMENT DEVICE ID IE

MeasurementDeviceID ::= INTEGER (0..5)


-- MEASUREMENT INFO IE IN RESULT MESSAGE

TOA-AddMeasurementInfo ::= SEQUENCE {
    toa-Method              TOA-Method,             -- defined earlier
    toa-Diversity           TOA-Diversity,
    toa-NumberOfBurst           TOA-NumberOfBurst,      -- defined earlier
    toa-AOA             TOA-AOA         OPTIONAL,
    toa-AOAUncertainty      TOA-AOAUncertainty  OPTIONAL
}

TOA-Diversity ::= INTEGER {
    noDiversity (0),
    diversity (1)
} (0..3)


TOA-AOA ::= INTEGER (0..3599)

TOA-AOAUncertainty ::= INTEGER (0..31)


-- PEAKS LIST OF MEASURED TOAs

TOA-MeasuredPeakList ::= SEQUENCE (SIZE(0..4)) OF TOA-MeasuredPeaks
        -- list of peaks
```

```
-- MEASURED TOA IE

TOA-MeasuredPeaks ::= SEQUENCE {
    toa-MeasuredTOA         MeasuredTOA,
    toa-QualityInfo         TOA-QualityInfo
}

MeasuredTOA ::= INTEGER (-131072..131071)
    -- the absolute TOA value

TOA-QualityInfo ::= SEQUENCE {
    toa-Uncertainty         TOA-Uncertainty     OPTIONAL,
    snrEstimate             SNREstimate         OPTIONAL,
    toaSignalStrength           TOASignalStrength       OPTIONAL
}

TOA-Uncertainty ::= INTEGER (0..63)
    -- the uncertainty of the TOA estimate

SNREstimate ::= INTEGER (-30..33)
    -- the estimated value for Signal Noise Radio

TOASignalStrength ::= INTEGER (0..63)
    -- range -150 to -24 with 2dBm steps

END


-- The definition below will be imported from MAP specification.
--
--
-- MAP-ExtensionDataTypes {
--   ccitt identified-organization (4) etsi (0) mobileDomain (0)
--   gsm-Network (1) modules (3) map-ExtensionDataTypes (21) version4 (4)}
--
-- DEFINITIONS
--
-- IMPLICIT TAGS
--
-- ::=
--
-- BEGIN
--
-- EXPORTS
--
--  PrivateExtension,
--  ExtensionContainer;
--
--
--
-- MAP-EXTENSION  ::= CLASS {
--  &ExtensionType              OPTIONAL,
--  &extensionId    OBJECT IDENTIFIER }
--  -- The length of the Object Identifier shall not exceed 16 octets and the
--  -- number of components of the Object Identifier shall not exceed 16
--
--
--
-- data types
--
-- ExtensionContainer ::= SEQUENCE {
--  privateExtensionList    [0]PrivateExtensionList OPTIONAL,
--  pcs-Extensions  [1]PCS-Extensions   OPTIONAL,
--  ...}
--
-- PrivateExtensionList ::= SEQUENCE SIZE (1..maxNumOfPrivateExtensions) OF
--              PrivateExtension
--
-- PrivateExtension ::= SEQUENCE {
--  extId       MAP-EXTENSION.&extensionId
--              ({ExtensionSet}),
--
--  extType     MAP-EXTENSION.&ExtensionType
--              ({ExtensionSet}{@extId})    OPTIONAL}
--
-- maxNumOfPrivateExtensions  INTEGER ::= 10
--
-- ExtensionSet     MAP-EXTENSION ::=
```

```
--      {...
--       -- ExtensionSet is the set of all defined private extensions
--  }
--
--  Unsupported private extensions shall be discarded if received.
--
--
-- PCS-Extensions ::= SEQUENCE {
--  ...}
--
-- END
```

11.1.3 Identifiers definition

In the informative annexes the contents of the identifiers used in operation and error types description are further discussed.

Annex A (informative): RIT messages

A.1 Introduction

This annex describes the contents of Radio Interface Timing (RIT) related messages.

A.2 Messages

The messages below are considered to be transported between the SMLC and the LMU.

A.2.1 RIT Measurement Request Message

The RIT Measurement Request is a message from the SMLC to the LMU. As a response to it the LMU performs Real Time Difference (RTD) or Absolute Time Difference (ATD) measurements. It contains the following information elements.

Table A.1: RIT Measurement Request message content

Information element	Type/Reference	Presence
Message Type	Message Type A.2.1.1.1	M
Measurement Instructions	Measurement Instructions A.2.1.1.2	M
BTS List	BTS List A.2.1.1.3	C

A.2.1.1 RIT Measurement Request Message Information Elements

A.2.1.1.1 Message Type IE

This IE contains the type of the message. This IE is mandatory.

A.2.1.1.2 Measurement Instructions IE

The purpose of the Measurement Instructions IE is to inform the LMU about the measurement type (RTD/ATD), measurement result reporting rate, and tell which BTSs should be measured. This IE is mandatory, and it contains the following fields:

Measurement Type

This field indicates whether AT of reference BTS is required.

'0': AT of reference BTS should be reported. If AT of reference BTS can not be measured, no ATD/RTD measurements are reported, but RIT Error IE is sent instead.

'1': AT of reference BTS should be reported . If AT of reference BTS can not be measured, ATD/RTD measurements are reported anyhow.

'2': ATD/RTD measurements timestamped with frame number of the reference BTS should be performed.

Reporting Period Format

This field describes the units of the Reporting Period field. This field is optional. If this field is included, RIT Measurement Responses shall be send with the period indicated in this and Reporting Period fields.

'0': Reporting Period is told in tens of seconds.

'1': Reporting Period is in tens of minutes.

Reporting Period

This field describes the value for the reporting period, i.e. the required time period between the RIT Measurement Response messages. Its units and multiplication factor are defined in the Reporting Period Format field. This field is conditional and included only if the Reporting Period Format is included.

Range: 0-120

Change Limit

This field indicates the limit for the change of AT or ATD /RTD values in units of 0.02 micro-seconds. If any AT or ATD/RTD value has changed more than the value in this field since the last RIT Measurement Response, a new RIT Measurement Response message is sent. This field is optional. If this field is included, RIT Measurement Responses shall be send when some RIT value has changed more than this limit.

Range: 1-255

Deviation Limit

This field indicates the limit for the deviation of the AT or ATD/RTD values. If any time the predicted AT or ATD/RTD value (based on reported AT or ATD/RTD values and changes in the last RIT Measurement Response) has deviated more than the value in this field compared to the current measurement result, a new RIT Measurement Response message is sent. This field is optional. If this field is included, RIT Measurement Responses shall be send when the first deviation of some RIT value is more than this limit. The values are in units of 0.02 micro-seconds.

Range: 1-255

NOTE: Predicted AT or ATD/RTD value means the value that is calculated (extrapolated) based on AT or ATD/RTD value and AT or ATD/RTD Change value in last RIT Measurement Response message.

Monitor Period

This field indicates the requested time period for monitoring the time derivative of AT or ATD/RTD values, i.e. on how long monitor period the reported AT or ATD/RTD change is based. The value is in tens of seconds. This field is optional

Range: 1- 6

Environment Characterization

Environment Characterization field gives a LMU information about expected multipath and NLOS in the area.

'0': possibly heavy multipath and NLOS conditions (e.g. bad urban or urban)

'1': no or light multipath and usually LOS conditions (e.g. suburban or rural)

'2': not defined or mixed environment

'3': reserved

'4': reserved (i.e. several values should be reserved)

Neighbor Number

This field indicates the maximum number of neighbor BTSs that the LMU should try to report.

Range: 0-15

Neighbor Type

This field indicates which neighbor BTSs are used for RIT measurements. If the value of the Neighbor Number field is lower than the total number of BTSs in the required list, then the BTS are selected in the order of the list.

'0':Neighbor BTSs listed in the BTS List IE are used for RIT measurements in the order of the list.

'1': If possible, neighbor BTSs listed in the BTS List IE are used, otherwise neighbors received in SYSTEM INFORMATION 2 or 5 message are used in the order of received signal strength.

'2': Neighbor BTSs indicated in SYSTEM INFORMATION TYPE 2 or 5 are used for RIT measurements (i.e. this is normal operation) in the order of received signal strength.

'3': All neighbor BTSs that can be received (i.e. reported BTSs are not limited to BTSs listed in SYSTEM INFORMATION TYPE 2 or 5 or BTS List IE). Support of this option in LMU is optional.

CellIdMethod

CellIdMethod field indicates whether CI or BSIC and BCCH carrier is used to identify neighbor BTSs in RIT Measurement Responses.

'0' = BSIC and BCCH carrier are used to identify the cell, even if CI is available.

'1' = CI is used to identify the neighbor cell, if it is available, otherwise BSIC and BCCH carrier are used.

A.2.1.1.3 BTS List IE

This information element indicates neighbor BTSs that are used for RIT measurements. This IE is conditional. If Neighbor Type field in the Measurement Instructions IE is '0' or '1' this field must be included. The first BTS on the list is the reference BTS that should be used as reference when reporting the RTD or AT values. If this reference BTS is not available, the LMU can select the used reference BTS based on signal strength.

This IE contains the following fields.

Number of BTSs

This field indicates, how many BTSs are included in this IE.

Range: 1 to 31.

The following fields are repeated the number of times included in Number of BTSs field.

CI

This field indicates the Cell Identity of the particular BTS. The purpose of the Cell Identity value is to identify a BTS within a location area.

Range: 0 - 65535

NOTE: Here is assumed that when LMU starts to make measurements, it firsts goes to the requested frequencies, and starts to decode BSICs and CIs from those specific frequencies. Because of this procedure the risk that there would be two BTSs with same CIs and same Channel numbers is minimal (i.e. there is no need to transmit LAC).

Time Slot Scheme

The Time Slot Scheme field indicates what kind of transmission scheme the particular BTS is using. If the LMU measures signals from BTSs from other time slots than 0 or 4, and it is informed about the burst length schemes used by BTSs, then it can compensate for the possible error. (This is necessary if the LMU averages bursts from different time slots, and the BTS uses varying lengths of bursts.)

'0' = the burst scheme is unknown (The time slot should remain the same)

'1' = all time slots are 156.25 bits long

'2' = time slots 0 and 4 are 157 bits long and other time slots are 156 bits long

BSIC

This field indicates the BSIC (Base Station Identity Code) of the particular BTS.

Range: 0 - 63

BCCH Carrier

This field indicates the absolute RF channel number of the particular BTS.

Range: 0 - 1023

A.2.2 RIT Measurement Response Message

The RIT Measurement Response is a message from the LMU to the SMLC. It is the response to the RIT Measurement Request. It contains the following information elements.

Table A.2: RIT Measurement Response message content

Information element	Type/Reference	Presence
Message Type	Message Type A.2.2.1.1	M
RIT Measurement	RIT Measurement A.2.2.1.2	M

A.2.2.1 RIT Measurement Response Message Information Elements

A.2.2.1.1 Message type IE

This IE contains the type of the message. This IE is mandatory.

A.2.2.1.2 RIT Measurement IE

This IE includes the required RIT measurements. The length of this IE depends on the number of measured neighbor BTSs. This IE is mandatory.

Reference LAC

This field indicates the Location Area Code of the reference BTS. The purpose of the Location Area Code is to identify a location area.

Range: 0 - 65535

Reference CI

This field indicates the Cell Identity value of the reference BTS. The purpose of the Cell Identity value is to identify a cell within a location area.

Range: 0 - 65535

Reference Frame Number

This field indicates the frame number of the last measured burst from the reference BTS.

Range: 0 - 2715647

Response Type

This field indicates whether AT of reference BTS is reported or not.

'0': AT of reference BTS is not reported

'1':AT of reference BTS is reported

Common Clock

This field indicates the type of the common reference clock for AT measurement. This field is included only if the Response Type field is '1'.

'0': GPS clock is used.

'1': Reserved for future use (e.g. Synchronized atomic clocks, or GLONASS)

Reference AT

This field indicates the measured AT value for the serving BTS. It is the starting moment of a time slot. It is counted in two parts: seconds after last minute change, and nanoseconds after last second change.This field is included only if the Response Type field is '1'.

Range:

seconds: 0-59

nanoseconds: 0-999,999,999

Reference AT Quality Resolution

Reference AT Quality Resolution field includes the resolution used in Reference AT Quality field. Encoding on 2 bits as follows

'00' 0.005 micro seconds

'01' 0.01 micro seconds

'10' 0.05 micro seconds

'11' Reserved.

This field is included only if the Response Type field is '1'.

Reference AT Quality

Reference AT Quality field includes the quality of reported RIT measurement. This Reference AT Quality field can be e.g. used to evaluate the reliability of AT measurements in the SMLC. Reference AT quality is defined as

Reference AT Quality = $\sqrt{E\left[(x-\mu)^2\right]}$ = Std of reported AT value,

where x is the reported Reference AT value and $\mu = E[x]$ is its expectation value. The reporting resolution of Reference AT Quality is defined by Reference AT Quality resolution field.

Range: 0 to 63

Value 63 means that Reference AT Quality is greater than or equal to R*63, where R is the resolution defined in Reference AT Quality Resolution field.

This field is included only if the Response Type field is '1'.

Reference AT Change

This field indicates the first time derivative of the AT value for the reference BTS. This value is based on measurements made during Monitor Period, if the monitoring period is provided. Otherwise it is the best estimate of AT Change value at the time of last AT measurement. This field is conditional and included if Response Type field is '1'. The range is -0.05 … 0.05 ppm and resolution is 0,00005 ppm.

Range: -1000 … 1000

Reference AT Change Quality Resolution

Reference AT Change Quality Resolution field includes the resolution used in Reference AT Change Quality field. Encoding on 2 bits as follows

'00' 0.00005 ppm

'01' 0.0001 ppm

'10' 0.0005 ppm

'11' Reserved.

This field is conditional and included if the Response Type field is '1'.

Reference AT Change Quality

Reference AT Change Quality field includes the quality of reported Reference AT Change. This Reference AT Change Quality field can be e.g. used to evaluate the reliability of RIT measurements in the SMLC. Reference AT Change Quality is defined as

Reference AT Change Quality = $\sqrt{E\left[(x-\mu)^2\right]}$ = Std of reported AT Change value

where x is the reported Reference AT Change and $\mu = E[x]$ is its expectation value. The reporting resolution of Reference AT Change Quality is defined by Reference AT Change Quality Resolution field.

Range: 0 to 63

This field is conditional and included if the Response Type field is '1'.

Reference Time Slot

Reference Time Slot indicates the time slot relative to which the LMU reports the reference BTS measurements. This field is mandatory.

Range: 0 to 7

NOTE: If the LMU does not know timeslot scheme, the LMU reports the used timeslot. The LMU can only report results based on one time slot (N) or two time slots (N and N+4). If the LMU knows timeslot scheme, the LMU can make measurements from several timeslots and reports that the used timeslot is zero (and makes correction).

Reference RX Level

RX Level field includes the received signal strength of the reference BTS.

The RX Level is expressed in 2 dBm steps within the range -150 .. –24 dBm.

Range: 0 .. 63

ATD/RTD Quality Resolution

ATD/RTD Quality Resolution field includes the resolution used in ATD/RTD Quality field. Encoding on 2 bits as follows

'00' 0.005 micro seconds

'01' 0.01 micro seconds

'10' 0.05 micro seconds

'11' Reserved.

This field is mandatory.

ATD/RTD Change Quality Resolution

ATD/RTD Change Quality Resolution field includes the resolution used in ATD/RTD Change Quality field. Encoding on 2 bits as follows

'00' 0.00005 ppm

'01' 0.0001 ppm

'10' 0.0005 ppm

'11' Reserved.

This field is mandatory.

Number of Measured Neighbors

This field indicates the number of different neighbor BTSs.

NOTE: If the LMU can not measure any neighbor BTSs, then this value is set to '0'.

Range: 0 – 15

The following fields are repeated the number of times included in Number of Measured Neighbors field.

CellIdType

This field indicates is the identity method of the cell.

'0' = Cell identity is told using BSIC and BCCH carrier.

'1' = Cell identity is told using CI.

Neighbor CI

This field indicates the Cell Identity of the particular neighbor cell. The purpose of the Cell Identity value is to identify a cell within a location area.

Neighbor CI field is a conditional field and it is included only if CellIdType is set '1' and CI value of the given cell is available.

Range: 0 - 65535

Neighbor BSIC

This field indicates the BSIC (Base Station Identity Code of the base station).

BSIC field is conditional and it is included only if CellIdType is set '0'.

Range: 0 - 63

Neighbor BCCH Carrier

This field indicates the absolute RF channel number of the neighbor base station. BCCH carrier field is conditional and it is included only if CellIdType is set '0'.

Range: 0 - 1023

Neighbor RX Level

RX Level field includes the received signal strength on the neighbor BTS.

The RX Level is expressed in 2 dBm steps within the range -150 .. –24 dBm.

Range: 0 .. 63

Neighbor Frame Number

This field indicates the calculated value of the neighbor BTS's frame that would have been received at the same time or immediately after as the last measured frame from the reference BTS. This field is optional.

Range: 0 - 2715647

Neighbor Time Slot

Neighbor Time Slot indicates the time slot relative to which the LMU reports the serving BTS measurements. This field is mandatory.

Range: 0 to 7

NOTE: If the LMU does not know timeslot scheme, the LMU reports the used timeslot. The LMU can only report results based on one time slot (N) or two time slots (N and N+4). If the LMU knows timeslot scheme, the LMU can make measurements from several timeslots and reports that the used timeslot is zero (and makes correction).

ATD/RTD Value

This field indicates the measured ATD/RTD value between the receptions of signals from the reference and the neighbor BTS. This ATD/RTD value is the difference in reception of signal (the starting moment of time slot) from reference BTS compared to the signal (next starting moment of a time slot) from the neighbor BTS (i.e. this value is always positive). This field is mandatory. The reporting resolution of ATD/RTD value is 0.005 micro-seconds.

Range: 0 … 923200

NOTE: The reported ATD/RTD value may be based on some filtering or estimation algorithm. I.e. the reported value is not the last measurement result, it is the best estimate of real RTD value at the time of last measurement.

ATD/RTD Quality

ATD/RTD Quality field includes the quality of reported RIT measurement. This ATD/RTD Quality field can be e.g. used to evaluate the reliability of RIT measurements in the SMLC. ATD/RTD quality is defined as

ATD/RTD Quality = $\sqrt{E\left[(x-\mu)^2\right]}$ = Std of reported ATD/RTD value,

where x is the reported ATD/RTD value and $\mu = E[x]$ is its expectation value. The reporting resolution of ATD/RTD Quality is defined by ATD/RTD Quality resolution field.

Range: 0 to 63

This field is mandatory.

ATD/RTD Change

This field indicates the first time derivative of the ATD/RTD value between the receptions of signals from the reference and the neighbor BTS. This value is based on measurements made during Monitor Period, if the monitoring period is provided. Otherwise it is the best estimate of the ATD/RTD Change value at the time of last ATD/RTD measurement. The range is -0.1 … 0.1 ppm and resolution is 0,00005 ppm.

Range: -2000 … 2000

ATD/RTD Change Quality

ATD/RTD Change Quality field includes the quality of reported ATD/RTD Change. This ATD/RTD Change Quality field can be e.g. used to evaluate the reliability of RIT measurements in the SMLC. ATD/RTD Change Quality is defined as

ATD/RTD Change Quality = $\sqrt{E\left[(x-\mu)^2\right]}$= Std of reported ATD/RTD Change value,

where x is the reported ATD/RTD Change and $\mu = E[x]$ is its expectation value. The reporting resolution of ATD/RTD Change Quality is defined by ATD/RTD Change Quality resolution field.

Range: 0 to 63

This field is mandatory.

A.2.3 RIT Measurement Stop Message

The RIT Measurement Stop is a message from the SMLC to the LMU. It is sent when the SMLC wants the LMU to stop doing RIT measurements and reporting them. It contains the following information elements.

Table A.3: RIT Measurement Stop message content

Information element	Type/Reference	Presence
Message Type	Message Type A.2.3.1.1	M

A.2.3.1 RIT Measurement Stop Message Information Elements

A.2.3.1.1 1Message type IE

This IE contains the type of the message. This IE is mandatory.

A.2.4 RIT Measurement Error Message

The RIT Measurement Error is a message from the LMU to the SMLC. It is sent any time when the LMU can not perform RIT measurements asked for in the RIT Measurement Request. This message can be returned in return result (after reception of measurement command) or as separate message (during periodic measurement). It contains the following information elements.

Table A.4: RIT Measurement Error message content

Information element	Type/Reference	Presence
Message Type	Message Type A.2.4.1.1	M
Error Type	RIT Error Type A.2.4.1.2	M
RIT Error	RIT Error A.2.4.1.3	M

A.2.4.1 RIT Measurement Error Message Information Elements

A.2.4.1.1 Message type IE

This IE contains the type of the message. This IE is mandatory.

A.2.4.1.2 RIT Error Type IE

This IE indicates whether the error is temporarily (e.g. GPS reset) or permanent errors. Permanent error requires actions in SMLC, temporarily error informs that LMU can not send results temporarily (but it is expected to recover without any actions from SMLC).

'0' = Permanent error

'1' = Temporarily error

A.2.4.1.3 RIT Error IE

The purpose of the RIT Error IE is to provide the indication of error and the reason for it, when the LMU can not report required RIT results. This IE is mandatory. This IE has the following fields.

Error Reason

This field indicates the reason for error.

'0': There were no neighbor BTSs to be received.

'1': No ATD measurements were possible, since the common reference clock was not available.

'2': Requested type of measurements is not supported.

'3': Undefined error.

Annex B (informative): TOA messages

B.1 Messages

The following TOA related messages are exchanged between the SMLC and the LMU.

1) Perform TOA Measurement (MLC->LMU)

2) TOA Measurement Result (response to 1. LMU-> MLC)

B.1.1 Perform TOA Measurement Message

The Perform TOA Measurement is a message from the SMLC to the LMU. As a response to it the LMU measures Time Of Arrival of MS transmitted signals. The signal characteristics are specified in the message. It contains the following information elements.

Table B.1: Perform TOA Measurement message content

Information element	Type/Reference	Presence
Message Type	Message Type IE 3.1	M
Measurement Device Info	Measurement Device Info IE 3.2	M
Channel Description	Channel Description IE 3.3	M
Signal Description	Signal Description IE 3.4	M
Timing Description	Timing Description IE 3.5	M
Measurement Options	Measurement Options IE 3.6	O

B.1.2 TOA Measurement Result Message

The TOA Measurement Result is a message from the LMU to the MLC. It is a response to the Perform TOA Measurement message and contains the following information elements.

Table B.2: TOA Measurement Result message content

Information element	Type/Reference	Presence
Message Type	Message Type IE 3.1	M
Number of Measurement Devices	Number of Measurement Devices IE 3.7	M
Timing Info	Timing Info IE 3.8	M
The following is repeated "Number of Measurement Devices" times		
Measurement Device ID	Measurement Device ID IE 3.10	M
Measurement Info	Measurement Info IE 3.11	M
Number of Peaks	Number of Peaks IE 3.12	M
The following is repeated "Number of Peaks" times		
Measured TOA	Measured TOA IE 3.13	M
TOA Quality	TOA Quality IE 3.14	M

B.2 Information element encodings

B.2.1 Message Type IE

This IE contains the type of the message.

Range: 0 – 255

B.2.2 Measurement Device Info IE

This IE indicates the LMU Measurement Devices that are addressed with the message. (One physical LMU may contain several devices, e.g. an LMU co-located with a three sector site would normally contain three devices). It contains the following fields:

Number of Measurement Devices

This field indicates the number of LMU Measurement Devices that are addressed with the message. This field is mandatory.

Range: 1-6

The following field is repeated "Number of Measurement Devices" times.

Measurement Device ID

This field indicates the ID of the LMU Measurement Device.

Range: 0 -5

B.2.3 Channel Description IE

The purpose of the Channel Description IE is to inform the LMU about the physical channel used by MS. This IE contains the following fields:

Frequency List Type

This field describes the format of the frequency information. If both frequency list and index is provided then the LMU shall store the frequency list and its associated index. If only an index is provided the LMU shall use the associated frequency list.

'0': Frequency list only

'1': Frequency list and index

'2': Frequency list index only

Frequency list index

This field identifies a frequency list either provided with this message or stored by the LMU. This field is present when "Frequency List Type" is equal to 1 or 2.

Range: 0-31

Number of ARFCNs

This field indicates the number of frequencies used by MS. This field is present if "Frequency List Type" is equal to 0 or 1.

Range: 1-64

The following field is repeated the number of times indicated by the "Number of ARFCNs" field.

ARFCN

This field indicates the absolute radio frequency number. This field is present if "Frequency List Type" is equal to 0 or 1.

Range: 0-1023

Hopping

This field indicates if frequency hopping is used. This field is mandatory.

'0': No hopping

'1': Hopping

MAIO

This field indicates the Mobile Allocation Index Offset used in the frequency hopping algorithm (see 3GPP TS 05.02). This field is present if Hopping='1'.

Range: 0-63

HSN

This field indicates the Hopping Sequence Number used in the frequency hopping algorithm (see 3GPP TS 05.02). This field is present if Hopping='1'.

Range: 0-63

Frame Number

This field indicates the Frame Number modulo 84864 of the first burst expected from the MS. It is used in the frequency hopping algorithm (see 3GPP TS 05.02). This field is present if Hopping='1'.

Range: 0-84863

Channel Type

This field indicates the channel type. This field is mandatory.

'0': TCH/F

'2': TCH/H SCN=0

'3': TCH/H SCN=1

Number of Bursts

This field indicates the number of bursts to measure TOA on. This field is mandatory. The field is coded as follows

Value	Number of Bursts
0	5
1	10
2	20
3	40
4	70
5	140
6	280
7	560

B.2.4 Signal Description IE

The purpose of the Signal Description IE is to inform the LMU about the signal transmitted by MS. It contains the following fields:

Burst Type

This field contains the burst type transmitted by MS.

'0': Access Burst

'1': Normal Burst

Handover Reference

This field contains the handover reference number which together with BSIC completely defines the data portion of the access burst. This field is present when Burst Type = '0'.

Range: 0 -255

BSIC

This field indicates the BSIC (Base Station Identity Code) which together with Handover Reference Number defines the data portion of an access burst. This field is present when Burst Type= '0'.

Range: 0 – 63

TSC

This field indicates the Training Sequence Code used by MS. This field is present when Burst Type='1'.

Range: 0-7

B.2.5 Timing Description IE

This IE provides information about the predicted arrival time of MS signals. It contains the following fields:

Time Reference

This field indicates the used clock reference. This field is mandatory.

'0': GPS time

'1': GSM time

'2'-'3': Reserved for future use

GPS Start Time

This field indicates the predicted signal arrival time expressed in GPS time. The signal arrival time (TOA) is defined as the start point of a time slot. It is counted in units of 4 micro-second modulo 60s. To remove any ambiguity, let RT denote the reception time, ST denote the start time, and T an arbitrary time. Then if

1) (ST-RT) mod 60s <= 40s

   then the indicated start time is the next time when T mod 60s is equal to ST.

   It is possible that a request arrives late so that 1) is not fulfilled but before all bursts have been transmitted. It is in such a case possible to perform measurements on the remaining bursts if condition

2) (RT-ST) mod 60s ≤ Δ.

   is fulfilled. Here Δ denotes the length of the complete measurement interval. It can be derived from the fields Channel Type and the Number of Bursts.

Should however neither of 1) or 2) be fulfilled then the request arrived too late and the bursts were missed.

This field is present when Time Reference='0'

Range: 0 – 14,999,999

GPS SV

This IE identifies a GPS clock SV (Space Vehicle) used for time stamping. Value 0 means that all available GPS sources should be used for deriving a time stamp. This field is present if Time Reference = '0'.

Range: 0-31

BCCH

This field indicates the ARFCN (BCCH) of the BTS whose clock is used as reference for Start Time. This field is present when Time Reference='1'.

Range: 0 – 1023

BSIC

This field indicates the Base Station Identity Code of the BTS whose clock is used as reference for Start Time. This field is present when Time Reference='1'.

Range: 0 – 63

GSM Start Time

This field indicates the predicted signal arrival time expressed in GSM time. It is expressed as Frame Number FN modulo 42432, Time slot Number TN and Bit Number BN. The reference point for signal arrival time (TOA) is defined as the start point of a time slot. The start time can encode only an interval of time of 42 432 frames, that is to say around 195.8 seconds. To remove any ambiguity, let RFN denote the frame number at reception, and FN' denote an arbitrary frame number. Then if

1) (FN-RFN) mod 42432 ≤ 31623

   then the indicated starting FN is the next time when FN' mod 42432 is equal to FN.

   It is possible that a request arrives late so that 1) is not fulfilled but before all bursts have been transmitted. It is in such a case possible to perform measurements on the remaining bursts if the condition

2) (RFN-FN) mod 42432 ≤ Δ.

   is fulfilled. Here Δ denotes the length of the complete measurement interval. It can be derived from the fields Channel Type and the Number of Bursts.

Should however neither of 1) or 2) be fulfilled then the request arrived too late and the bursts were missed.

This field is present when Time Reference='1'. It contains the following subfields:

FN (mod 42432):

Range: 0 – 42432

TN:

Range: 0 – 7

BN:

Range: 0 – 156

Start Time Uncertainty

This field indicates the uncertainty in the arrival of the signal from MS. Expressed in GSM bit periods (i.e. 48/13 micro-seconds). The burst is expected to arrive in the interval

[Start Time - Start Time Uncertainty, Start Time + Start Time Uncertainty]

This field is mandatory. The field is coded as follows.

Value	Uncertainty
0	2
1	3
2	4
3	5
4	7
5	10
6	13
7	17
8	20

9 25

10 35

11 45

12 55

13 65

14 90

15 140

B.2.6 Measurement Options IE

This IE indicates options for TOA measurement. It contains the following fields.

Method

This field defines the TOA algorithm to be used by LMU. A value of zero indicates that a default algorithm may be used. Remaining values are vendor specific. This field is mandatory.

Range: 0 – 7

Environment Characterization

This field indicates the expected multipath environment. This field is mandatory.

'0': possibly heavy multipath and NLOS conditions (e.g. bad urban or urban)

'1': no or light multipath and usually LOS conditions (e.g. suburban or rural)

'2': not defined or mixed environment

'3': reserved

'4': reserved (i.e. several values should be reserved)

Measurement Type

This field indicates whether LMU shall include an estimate of the Time of Arrival (TOA) and/or Angle of Arrival (AOA) with the measurement result.

'0': Report TOA only

'1': Report AOA only

'2': Report TOA and AOA

B.2.7 Number of Measurement Devices IE

This IE indicates the number of LMU Measurement Devices that are reporting with the message.

Range: 1-6

B.2.8 Timing Info IE

This IE provides information about the used clock source for TOA measurement. It contains the following fields:

Time Reference

This field indicates the used clock reference. This field is mandatory.

'0': GPS time

'1': GSM time

'2'-'3': Reserved for future use

BCCH

This field indicates the ARFCN (BCCH) of the BTS whose clock is used as clock reference. This field is present when Time Reference='1'.

Range: 0 – 1023

BSIC

This field indicates the Base Station Identity Code of the BTS whose clock is used as clock reference. This field is present when Time Reference='1'.

Range: 0 – 63

B.2.10 Measurement Device ID IE

This IE indicates the ID of the reporting LMU Measurement Device.

Range: 0 -5

B.2.11 Measurement Info IE

This IE indicates additional information related to the signal measurement.

Method

This field indicates the used method for TOA measurement. This field is mandatory.

Range: 0 – 7

Diversity

This field indicates if diversity was used for measurements. This field is mandatory.

'0': Diversity was not used.

'1': Diversity was used.

Measured Number of Bursts

This field indicates the number of bursts used for TOA measurement. It is expressed as a ratio N = (number measured)/(number requested). This field is mandatory. It is coded as follows.

0 $0 \leq N < 1/7$

1 $1/7 \leq N < 2/7$

2 $2/7 \leq N < 3/7$

3 $3/7 \leq N < 4/7$

4 $4/7 \leq N < 5/7$

5 $5/7 \leq N < 6/7$

6 $6/7 \leq N < 1$

7 $N=1$

Angle of Arrival

This field indicates the Angle of Arrival in units of 0.1 degrees. This field is optional.

Range: 0 - 3599

AOA Uncertainty

This field indicates the quality of Angle of Arrival (AOA) estimate in units of 0.1 degrees. It is defined as follows. Let Θ denote the estimated AOA, Θ_0 denote the true AOA, and r denote the uncertainty. Then Prob($|\Theta-\Theta_0| < r$) = 67%, i.e. with 67% confidence the true AOA lies in the interval [Θ-r, Θ+r]. The uncertainty r, expressed in degrees, is mapped to a number K, with the following formula:

$$r = C\left((1+x)^K - 1\right)$$

with C = 0.446 and x = 0,25. With $0 \le K \le 30$, a useful range between 0.1 degrees and 360 degrees is achieved for the uncertainty. K is the value being sent. A value of 31 means that the measurement failed. This field is optional.

Range: 0 -31

B.2.12 Number of Peaks IE

This IE indicates the number of peaks (i.e. TOA values) reported.

Range: 0 - 4

B.2.13 Measured TOA IE

This IE indicates the absolute TOA value (modulo the duration of a TDMA frame) determined by LMU. Expressed in units of 0.004 micro-seconds relative to the starting time.

Range: -131072 - +131071

B.2.14 TOA Quality IE

This IE indicates the TOA quality determined by LMU. It contains the following fields:

TOA Uncertainty

This field indicates the uncertainty of the TOA estimate. It is defined as follows. Let τ denote the estimated TOA, τ_0 denote the true TOA, and r denote the uncertainty. Then Prob($|\tau-\tau_0| < r$) = 67%, i.e. with 67% confidence the true TOA lies in the interval [τ-r, τ+r]. The uncertainty r, expressed in nanoseconds, is mapped to a number K, with the following formula:

$$r = C\left((1+x)^K - 1\right)$$

with C = 25 and x = 0.12. With $0 \le K \le 62$, a suitably useful range between 3 ns and 28 μs is achieved for the uncertainty. A value of 63 means that the measurement failed. This field is optional.

Range: 0 - 63

SNR Estimate

This field indicates the estimated Signal To Noise ratio. Values are expressed in steps of 1 dB ranging from –30 to + 33. This field is optional.

Range: 0 - 63

TOA Signal Strength

This field indicates the estimated Signal Strength. Values are expressed in steps of 2dBm from –150 to –24 dBm. This field is optional.

Range: 0 - 63

Annex C (informative): Status Messages

C.1 Introduction

This annex describes the contents of messages related to the status of an LMU.

C.2 Messages

The messages below are considered to be transported between the SMLC and the LMU.

C.2.1 Status Query Message

The Status Query is a message from the SMLC to the LMU. It contains the following information elements.

Table C.1: Status Query message content

Information element	Type/Reference	Presence
Message Type	Message Type C.2.1.1.1	M

C.2.1.1 Status Query Message Information Elements

C.2.1.1.1 Message Type IE

This IE contains the type of the message. This IE is mandatory.

C.2.2 Status Query Result Message

The Status Query Result is a message from the LMU to the SMLC. It contains the following information elements.

Table C.2: Status Query Result message content

Information element	Type/Reference	Presence
Message Type	Message Type 5.2.1.1	M
Time	Time C.2.2.1.2	M
RIT Status	RIT Status C.2.2.1.3	M
TOA Status	TOA Status C.2.2.1.4	M
O&M Status	O&M Status C.2.2.1.5	M

C.2.2.1 Status Query Result Message Information Elements

C.2.2.1.1 Message Type IE

This IE contains the type of the message. This IE is mandatory.

C.2.2.1.2 Time IE

This IE contains the time stamp for this message. This IE is mandatory, and it contains the following fields:

Reference LAC

This field indicates the Location Area Code of the reference BTS. The purpose of the Location Area Code is to identify a location area.

Range: 0 - 65535

Reference CI
This field indicates the Cell Identity value of the reference BTS. The purpose of the Cell Identity value is to identify a cell within a location area.

Range: 0 - 65535

Reference Frame Number
This field indicates the frame number of the last measured burst from the reference BTS.

Range: 0 - 2715647

C.2.2.1.3 RIT Status IE

The purpose of the RIT Status IE is to inform the SMLC about the status of on-going RIT related activity. This IE is mandatory, and it contains the following fields:

RIT Jobs
This field indicates the number of on-going RIT related jobs, i.e. the number of neighbor BTSs that are tried to be measured. Notice that 0 means that no RIT related activity is on-going.

Range: 0 – 63

C.2.2.1.4 TOA Status IE

The purpose of the TOA Status IE is to inform the SMLC about the status of on-going TOA related activity. This IE is mandatory, and it contains the following fields:

TOA Jobs
This field indicates the number of on-going TOA related jobs, i.e. the number of MSs that are tried to be measured. Notice that 0 means that no TOA related activity is on-going.

Range: 0 – 63

C.2.2.1.5 O&M Status IE

The purpose of the O&M Status IE is to inform the SMLC about the status of on-going O&M related activity. This IE is mandatory, and it contains the following fields:

O&M Jobs
This field indicates the number of on-going O&M related jobs.

Range: 0 – 63

C.2.3 Status Update Message

The Status Update is a message from the LMU to the SMLC. It contains the following information elements.

Table C.3: Status Response message content

Information element	Type/Reference	Presence
Message Type	Message Type C.2.3.1.1	M
Reason for Status Update	Reason for Status Update C.2.3.1.2	M
Time	Time C.2.2.1.2	M
RIT Status	RIT Status C.2.2.1.3	M
TOA Status	TOA Status C.2.2.1.4	M
O&M Status	O&M Status C.2.2.1.5	M

C.2.3.1 Status Update Message Information Elements

C.2.3.1.1 Message Type IE

This IE contains the type of the message. This IE is mandatory.

C.2.3.1.2 Reason for Status Update IE

This IE contains the reason for sending this Status Update Message. This IE is mandatory, and it contains the following fields:

Reason Code

This field indicates Reason code for sending this Status Update Message.

'0': power up (no knowledge about previous states)

'1': SW reset, unsuccessful recovery

'2': SW reset, successful recovery

'3': unknown selfdiagnosis error

'4': unreliable timebase error

'5': periodic status report, normal operation

Annex D (informative): Change History

Meeting#	CR	Rev	New Version	Subject/Comment
SMG#29			7.0.0	Approved at SMG#29 as Release 98
SMG#30bis	A001		7.1.1	Addition of further LCS functionality in GSM Release 98
SMG#32	A003		7.2.0	Modifications to O&M operations to adapt to 3GPP TS 12.71 and some minor editorial corrections
GP-05	A005	2	7.3.0	Modifications of quality information
GP-05	A009	1	7.3.0	ASN.1 References update

History

Document history		
V7.0.0	August 1999	Publication
V7.1.1	January 2000	Publication
V7.2.0	August 2000	Publication
V7.3.0	June 2001	Publication