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Foreword

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1 Scope

The present document specifies the E-UTRAN radio network layer signalling protocol for the SLm interface. The SLm Application Protocol (SLmAP) supports the functions of the SLm interface by signalling procedures defined in this document. SLmAP is developed in accordance to the general principles stated in TS 36.305 [2] and TS 36.456 [3].

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.
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[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 36.305: "Stage 2 functional specification of User Equipment (UE) positioning in E-UTRAN".

[3] 3GPP TS 36.456: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); SLm interface general aspects and principles".

[4] 3GPP TS 36.455: "LTE Positioning Protocol A (LPPa)".

[5] 3GPP TS 36.101: "User Equipment (UE) radio transmission and reception".

[6] 3GPP TS 23.032: "Universal Geographical Area Description (GAD)".

[7] 3GPP TS 36.413: " Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol".

[8] ITU-T Recommendation X.691 (2002-07): "Information technology - ASN.1 encoding rules - Specification of Packed Encoding Rules (PER)".

[9] 3GPP TS 36.111: "Location Measurement Unit (LMU) performance specification; User Equipment (UE) positioning in E-UTRAN".

[10] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Base Station (BS) radio transmission and reception".

[11] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Physical Channels and Modulation".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Elementary Procedure: SLmAP consists of Elementary Procedures (EPs). An Elementary Procedure is a unit of interaction between LMUs in the E-UTRAN and E-SMLCs in the EPC. These Elementary Procedures are defined separately and are intended to be used to build up complete sequences in a flexible manner. If the independence between some EPs is restricted, it is described under the relevant EP description. Unless otherwise stated by the restrictions, the EPs may be invoked independently of each other as standalone procedures, which can be active in

parallel. The usage of several SLmAP EPs together or together with EPs from other interfaces is specified in stage 2 specifications (e.g., TS 23.305 [2]).

An EP consists of an initiating message and possibly a response message. Two kinds of EPs are used:

- **Class 1:** Elementary Procedures with response (success and/or failure).
- **Class 2:** Elementary Procedures without response.

For Class 1 EPs, the types of responses can be as follows:

Successful:

- A signalling message explicitly indicates that the elementary procedure successfully completed with the receipt of the response.

Unsuccessful:

- A signalling message explicitly indicates that the EP failed.
- On time supervision expiry (i.e., absence of expected response).

Successful and Unsuccessful:

- One signalling message reports both successful and unsuccessful outcome for the different included requests. The response message used is the one defined for successful outcome.

Class 2 EPs are considered always successful.

3.2 Symbols

-

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

LMU	Location Measurement Unit
SLmAP	SLm Interface Application Protocol
SRS	Sounding Reference Signal
TNL	Transport Network Layer
UL RTOA	Uplink Relative Time of Arrival
UTDOA	Uplink Time Difference of Arrival

4 General

4.1 Procedure Specification Principles

The principle for specifying the procedure logic is to specify the functional behaviour of the terminating node exactly and completely. Any rule that specifies the behaviour of the originating node shall be possible to be verified with information that is visible within the system.

The following specification principles have been applied for the procedure text in clause 8:

- The procedure text discriminates between:

  1) Functionality which "shall" be executed

     The procedure text indicates that the receiving node "shall" perform a certain function Y under a certain condition. If the receiving node supports procedure X but cannot perform functionality Y requested in the REQUEST message of a Class 1 EP, the receiving node shall respond with the message used to report unsuccessful outcome for this procedure, containing an appropriate cause value.

2) Functionality which "shall, if supported" be executed

The procedure text indicates that the receiving node "shall, if supported," perform a certain function Y under a certain condition. If the receiving node supports procedure X, but does not support functionality Y, the receiving node shall proceed with the execution of the EP, possibly informing the requesting node about the not supported functionality.

- Any required inclusion of an optional IE in a response message is explicitly indicated in the procedure text. If the procedure text does not explicitly indicate that an optional IE shall be included in a response message, the optional IE shall not be included. For requirements on including *Criticality Diagnostics* IE, see clause 10.

4.2 Forwards and Backwards Compatibility

The forwards and backwards compatibility of the protocol is assured by mechanism where all current and future messages, and IEs or groups of related IEs, include ID and criticality fields that are coded in a standard format that will not be changed in the future. These parts can always be decoded regardless of the standard version.

4.3 Specification Notations

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

Procedure	When referring to an elementary procedure in the specification the Procedure Name is written with the first letters in each word in upper case characters followed by the word "procedure", e.g., E-RAB procedure.
Message	When referring to a message in the specification the MESSAGE NAME is written with all letters in upper case characters followed by the word "message", e.g., MESSAGE NAME message.
IE	When referring to an information element (IE) in the specification the *Information Element Name* is written with the first letters in each word in upper case characters and all letters in Italic font followed by the abbreviation "IE", e.g., *Information Element* IE.
Value of an IE	When referring to the value of an information element (IE) in the specification the "Value" is written as it is specified in subclause 9.2 enclosed by quotation marks, e.g., "Value".

5 SLmAP Services

SLmAP provides the signalling service between E-SMLC and the Location Measurement Unit (LMU) that is required to fulfil the SLmAP functions described in clause 7. The procedures are divided into two groups:

1. UTDOA Measurement Information Transfer procedures;
2. SLm Interface Management procedures.

6 Services Expected from Signalling Transport

The signalling connection shall provide in sequence delivery of SLmAP messages. SLmAP shall be notified if the signalling connection breaks.

7 Functions of SLmAP

The SLmAP protocol has the following functions:

- Measurement Information Transfer. This function allows the E-SMLC to exchange measurement information with the LMU for the purpose of UTDOA positioning.
- SLm interface management. This function allows initialization of the SLm interface and exchange of capability information between the E-SMLC and LMU.
- Reporting of general error situations. This function allows proper error reporting and handling.

Table 7.1: Mapping between SLmAP functions and LPPa EPs

Function	Elementary Procedure(s)
Measurement Information Transfer	a) Measurement b) Measurement Update c) Measurement Abort
SLm Interface Management	a) SLm Setup b) Reset
Reporting of general error situations	Error Indication

8 SLmAP Procedures

8.1 List of SLmAP Elementary procedures

In the following tables, all EPs are divided into Class 1 and Class 2 EPs (see subclause 3.1 for explanation of the different classes):

Table 8.1.1: Class 1 procedures

Elementary Procedure	Initiating Message	Successful Outcome	Unsuccessful Outcome
		Response message	Response message
Measurement	MEASUREMENT REQUEST	MEASUREMENT RESPONSE	MEASUREMENT FAILURE
SLm Setup	SLm SETUP REQUEST	SLm SETUP RESPONSE	SLm SETUP FAILURE
Reset	RESET REQUEST	RESET ACKNOWLEDGE	

Table 8.1.2: Class 2 procedures

Elementary Procedure	Message
Measurement Update	MEASUREMENT UPDATE
Measurement Abort	MEASUREMENT ABORT
Error Indication	ERROR INDICATION

The following applies concerning interference between Elementary Procedures:

- The Reset procedure takes precedence over all other EPs.

8.2 Measurement Procedures

8.2.1 Measurement

8.2.1.1 General

The purpose of the Measurement procedure is to allow the E-SMLC to request the LMU to perform and report UL RTOA measurements for the purpose of UTDOA positioning.

8.2.1.2 Successful Operation

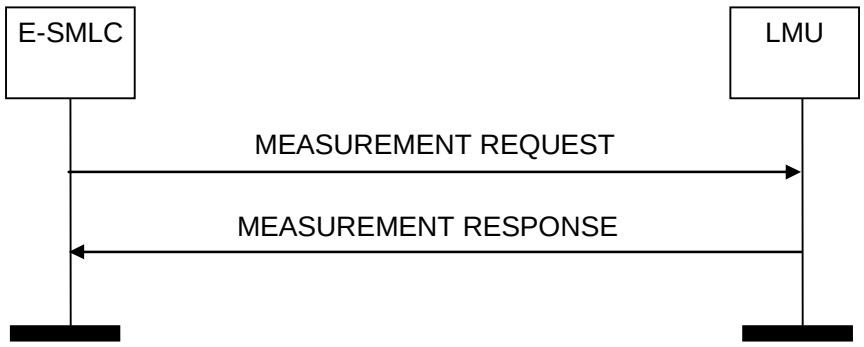

Figure 8.2.1.2.1: Measurement procedure. Successful operation.

The E-SMLC initiates the procedure by sending a MEASUREMENT REQUEST message to the LMU. The E-SMLC shall include the *deltaSS* IE in the MEASUREMENT REQUEST message if SRS sequence hopping is enabled for that particular measurement. If the *deltaSS* IE is included in the MEASUREMENT REQUEST message, the LMU shall consider that SRS sequence hopping is enabled for the measurement being requested. If the requested measurement has been successful, the LMU shall reply with a MEASUREMENT RESPONSE message.

8.2.1.3 Unsuccessful Operation

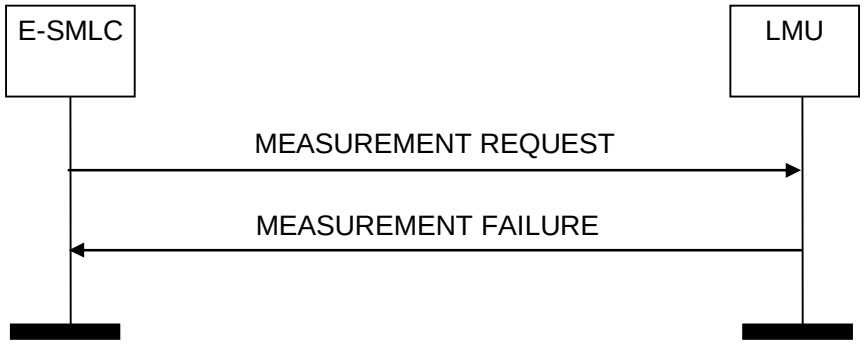

Figure 8.2.1.3.1: Measurement procedure. Unsuccessful operation.

If the LMU cannot successfully measure the UL RTOA for the target UE, it shall respond with a MEASUREMENT FAILURE message indicating the cause of the failure.

8.2.1.4 Abnormal Conditions

Not applicable.

8.2.2 Measurement Update

8.2.2.1 General

The purpose of the Measurement Update Procedure is to notify the LMU of a change in the previously signalled measurement configuration for one or more cells for the UE being positioned.

8.2.2.2 Successful Operation

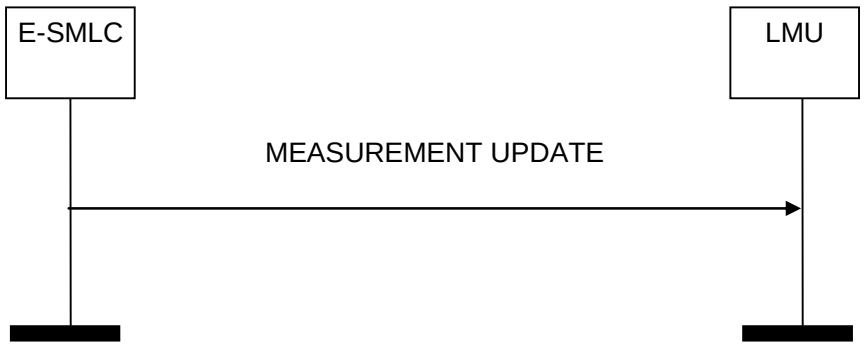

Figure 8.2.2.2.1: Measurement Update: Successful Operation.

The E-SMLC initiates the procedure by sending a MEASUREMENT UPDATE message. The E-SMLC shall include the *deltaSS* IE in the MEASUREMENT UPDATE message if SRS sequence hopping is enabled for that particular measurement. If the *deltaSS* IE is included in the MEASUREMENT UPDATE message, the LMU shall consider that SRS sequence hopping is enabled for the measurement.

Upon receiving the *UL RTOA Measurement Configuration* IE, the LMU shall overwrite the previously received measurement configuration information.

8.2.2.3 Unsuccessful Operation

Not applicable.

8.2.2.4 Abnormal Conditions

If the LMU cannot identify the previously requested measurement to be modified, it shall ignore the MEASUREMENT UPDATE message without taking further action.

8.2.3 Measurement Abort

8.2.3.1 General

The purpose of the Measurement Abort Procedure is to enable the E-SMLC to abort an on-going measurement identified by the E-SMLC Measurement ID.

8.2.3.2 Successful Operation

Figure 8.2.3.2.1: Measurement Abort Procedure: Successful Operation.

The E-SMLC initiates the procedure by sending a MEASUREMENT ABORT message.

Upon receiving this message, the LMU shall terminate the on-going measurement identified by the E-SMLC Measurement ID and may release any resources previously allocated for the same measurement.

8.2.3.3 Unsuccessful Operation

Not applicable.

8.2.3.4 Abnormal Conditions

If the LMU cannot identify the previously requested measurement to be aborted, it shall ignore the MEASUREMENT ABORT message without taking further action.

8.3 Management procedures

The following paragraphs describe the SLmAP interface management procedures.

8.3.1 SLm Setup

8.3.1.1 General

The purpose of the Setup procedure is to exchange application level data needed for the E-SMLC and the LMU to correctly interoperate on the SLm interface. This procedure shall be the first SLmAP procedure triggered after the TNL association has become operational.

8.3.1.2 Successful Operation

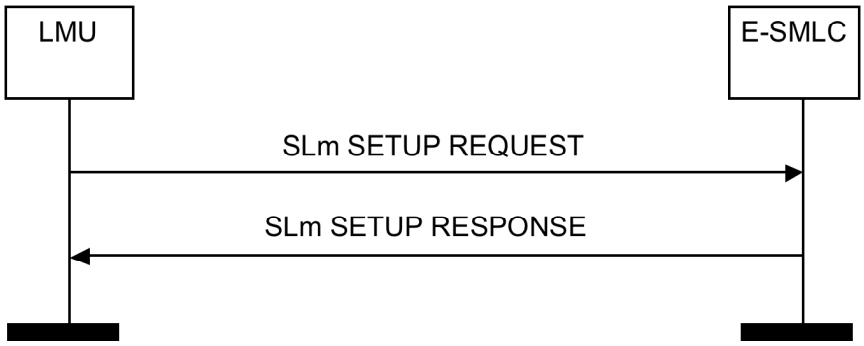

Figure 8.3.1.2.1: SLm Setup procedure: Successful Operation.

The LMU initiates the procedure by sending the SLm SETUP REQUEST message to the E-SMLC including the appropriate data. The E-SMLC responds with an SLm SETUP RESPONSE message.

The exchanged data shall be stored in respective node and used for the duration of the TNL association. When this procedure is finished, the SLm interface is operational and other SLmAP messages can be exchanged.

8.3.1.3 Unsuccessful Operation

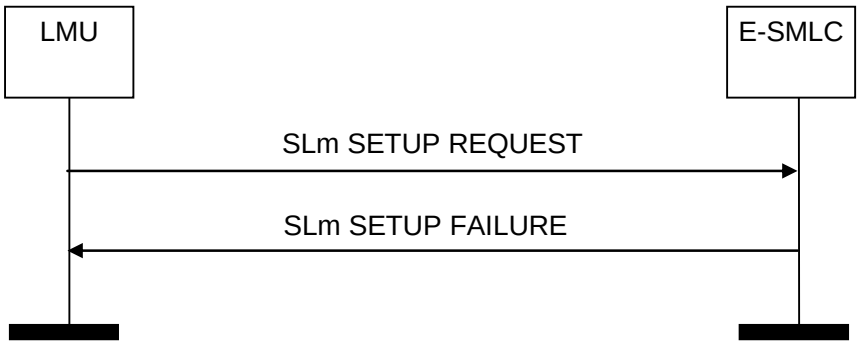

Figure 8.3.1.3.1: SLm Setup procedure: Unsuccessful Operation.

If the E-SMLC cannot accept the setup, it shall respond with an SLm SETUP FAILURE with an appropriate cause value.

8.3.1.4 Abnormal Conditions

Not applicable.

8.3.2 Reset

8.3.2.1 General

The purpose of the Reset procedure is to initialise or re-initialise the LMU SLmAP contexts in the event of a failure in either the LMU or E-SMLC. This procedure does not affect the application level configuration data exchanged during, e.g., the SLm Setup procedure.

8.3.2.2 Successful Operation

8.3.2.2.1 Reset Procedure Initiated from the E-SMLC

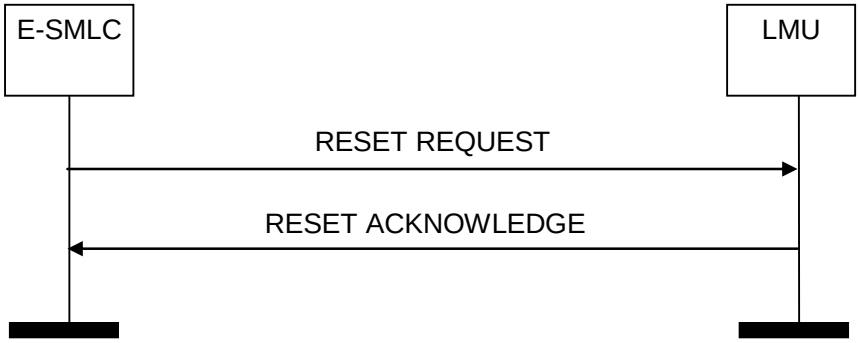

Figure 8.3.2.2.1.1: Reset procedure initiated from the E-SMLC.

In the event of a failure at the E-SMLC, which has resulted in the loss of some or all transaction reference information, a RESET REQUEST message should be sent to the LMU.

At reception of the RESET REQUEST message the LMU shall abort any other ongoing procedure (except another Reset procedure) on the same SLm interface, delete any measurement information related to the E-SMLC, release associated resources, and respond with the RESET ACKNOWLEDGE message.

8.3.2.2.2 Reset Procedure Initiated from the LMU

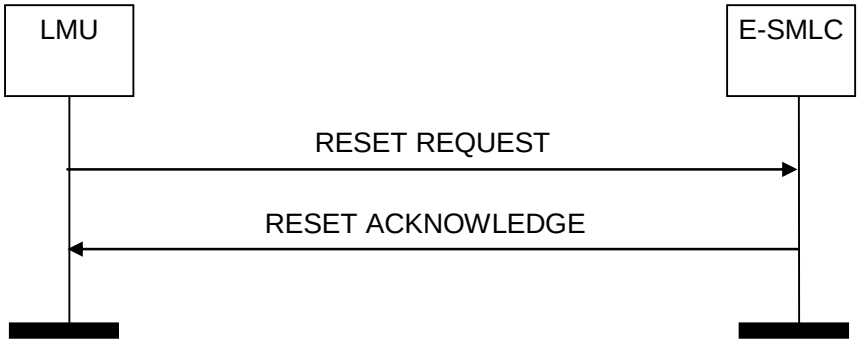

Figure 8.3.2.2.2.1: Reset procedure initiated from the LMU.

In the event of a failure at the LMU, which has resulted in the loss of some or all transaction reference information, a RESET REQUEST message shall be sent to the E-SMLC.

At reception of the RESET REQUEST message the E-SMLC shall abort any other ongoing procedure (except another Reset procedure) on the same SLm interface, delete any measurement information related to the LMU, release associated resources, and respond with the RESET ACKNOWLEDGE message.

8.3.2.3 Unsuccessful Operation

Void.

8.3.2.4 Abnormal Conditions

If a Reset procedure is ongoing in the LMU concerning one requesting E-SMLC and the LMU receives a RESET message from the same E-SMLC, the LMU shall respond with the RESET ACKNOWLEDGE message as described in 8.3.2.2.1.

If a Reset procedure is ongoing in the E-SMLC concerning one requesting LMU and the E-SMLC receives a RESET message from the same LMU, the E-SMLC shall respond with the RESET ACKNOWLEDGE message as described in 8.3.2.2.2.

If the requesting entity does not receive RESET ACKNOWLEDGE message, the requesting entity may reinitiate the Reset procedure towards the same receiving entity provided that the content of the new RESET REQUEST message is identical to the content of the previously unacknowledged RESET REQUEST message.

8.3.3 Error Indication

8.3.3.1 General

The Error Indication procedure is initiated by a node in order to report detected errors in one incoming message, provided they cannot be reported by an appropriate failure message.

8.3.3.2 Successful Operation

Figure 8.3.3.2.1: Error Indication procedure

When the conditions defined in clause 10 are fulfilled, the Error Indication procedure is initiated by an ERROR INDICATION message sent from the receiving node.

The ERROR INDICATION message shall contain at least either the *Cause* IE or the *Criticality Diagnostics* IE.

9 Elements for SLmAP Communication

9.1 Message Functional Definition and Content

9.1.1 MEASUREMENT REQUEST

This message is sent by the E-SMLC to request the LMU to make a UL RTOA measurement.

Direction: E-SMLC → LMU.

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	reject
SLmAP Transaction ID	M		9.2.3		-	
E-SMLC Measurement ID	M		9.2.12		YES	reject
UL RTOA Measurement Configuration	M		9.2.4		YES	reject

9.1.2 MEASUREMENT RESPONSE

This message is sent by the LMU to report UL RTOA measurements for the target UE.

Direction: LMU → E-SMLC.

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	reject
SLmAP Transaction ID	M		9.2.3		-	
E-SMLC Measurement ID	M		9.2.12		YES	reject
UL RTOA measurements	M		9.2.5		YES	reject
Criticality Diagnostics	O		9.2.11		YES	ignore

9.1.3 MEASUREMENT FAILURE

This message is sent by the LMU to report measurement failure.

Direction: LMU → E-SMLC.

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	reject
SLmAP Transaction ID	M		9.2.3		-	
E-SMLC Measurement ID	M		9.2.12		YES	reject
Cause	M		9.2.10		YES	ignore
Criticality Diagnostics	O		9.2.11		YES	ignore

9.1.4 SLm SETUP REQUEST

This message is sent by the LMU to setup SLm with E-SMLC.

Direction: LMU → E-SMLC

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	reject
SLmAP Transaction ID	M		9.2.3		-	
LMU ID	M		9.2.6		YES	ignore
LMU Information	O		9.2.8		YES	ignore

9.1.5 SLm SETUP RESPONSE

This message is sent by the E-SMLC to information LMU

Direction: E-SMLC → LMU

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	reject
SLmAP Transaction ID	M		9.2.3		-	
E-SMLC ID	M		9.2.7		YES	reject
Criticality Diagnostics	O		9.2.11		YES	ignore

9.1.6 SLm SETUP FAILURE

This message is sent by the E-SMLC to indicate SLm Setup failure.

Direction: E-SMLC → LMU

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	reject
SLmAP Transaction ID	M		9.2.3		-	
Cause	M		9.2.10		YES	ignore
Criticality Diagnostics	O		9.2.11		YES	ignore

9.1.7 RESET REQUEST

This message is sent from the E-SMLC to the LMU or vice versa in order to reset the SLm interface.

Direction: E-SMLC → LMU or LMU → E-SMLC.

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	reject
SLmAP Transaction ID	M		9.2.3		-	
Cause	M		9.2.10		YES	ignore

9.1.8 RESET ACKNOWLEDGE

This message is sent by the receiving entity as a response to a RESET REQUEST message.

Direction: E-SMLC → LMU or LMU → E-SMLC.

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	reject
SLmAP Transaction ID	M		9.2.3		-	
Criticality Diagnostics	O		9.2.11		YES	ignore

9.1.9 MEASUREMENT ABORT

This message is sent by the E-SMLC to request the LMU to abort the measurement identified by the E-SMLC Measurement ID.

Direction: E-SMLC → LMU.

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	reject
SLmAP Transaction ID	M		9.2.3		-	
E-SMLC Measurement ID	M		9.2.12		YES	reject

9.1.10 MEASUREMENT UPDATE

This message is sent by the E-SMLC to indicate to the LMU that the previously signalled measurement configuration for the target UE has changed for one or more cells, and to convey the SRS configuration for all cells with periodic SRS configured for the target UE.

Direction: E-SMLC → LMU.

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	reject
SLmAP Transaction ID	M		9.2.3		-	
E-SMLC Measurement ID	M		9.2.12		YES	reject
UL RTOA Measurement Configuration	M		9.2.4		YES	reject

9.1.11 ERROR INDICATION

This message is used to indicate that some error has been detected in the eNB or in the E-SMLC.

Direction: E-SMLC → eNB and eNB → E-SMLC.

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.2		YES	ignore
SLmAP Transaction ID	M		9.2.3		-	
Cause	O		9.2.0		YES	ignore
Criticality Diagnostics	O		9.2.11		YES	ignore

9.2 Information Element Definitions

9.2.1 General

Subclause 9.2 presents the SLmAP IE definitions in tabular format. The corresponding ASN.1 definition is presented in subclause 9.3. In case there is contradiction between the tabular format in subclause 9.2 and the ASN.1 definition, the ASN.1 shall take precedence, except for the definition of conditions for the presence of conditional elements, where the tabular format shall take precedence.

When specifying information elements which are to be represented by bitstrings, if not otherwise specifically stated in the semantics description of the concerned IE or elsewhere, the following principle applies with regards to the ordering of bits:

- The first bit (leftmost bit) contains the most significant bit (MSB);
- The last bit (rightmost bit) contains the least significant bit (LSB);
- When importing bitstrings from other specifications, the first bit of the bitstring contains the first bit of the concerned information;

9.2.2 Message Type

The *Message Type* IE uniquely identifies the message being sent. It is mandatory for all messages.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
Message Type				
>Procedure Code	M		INTEGER (0..63)	
>Type of Message	M		CHOICE (Initiating Message, Successful Outcome, Unsuccessful Outcome, …)	

9.2.3 SLmAP Transaction ID

The *SLmAP Transaction ID* IE is used to associate all the messages belonging to the same procedure. Messages belonging to the same procedure shall use the same Transaction ID.

The SLmAP Transaction ID is determined by the initiating peer of a procedure.

The SLmAP Transaction ID shall uniquely identify a procedure among all ongoing parallel procedures using the same procedure code, and initiated by the same peer.

IE/Group Name	Presence	Range	IE Type and Reference	Semantics Description
SLmAP Transaction ID	M		INTEGER (0..32767, …)	

9.2.4 UL RTOA Measurement Configuration

The purpose of the UL RTOA Measurement Configuration IE is to convey the UL RTOA measurement parameters to the LMU.

IE/Group Name	Presence	Range	IE Type and Reference	Semantics Description
UL RTOA Reference Time	M		BIT STRING (64)	Time in seconds relative to 00:00:00 on 1 January 1900 (calculated as continuous time without leap seconds and traceable to a common time reference) where binary encoding of the integer part is in the first 32 bits and binary encoding of the fraction part in the last 32 bits. The fraction part is expressed with a granularity of 1 /2**32 second. This IE is defined in reference to the SFN initialization time, TS 36.455 [4].
Search Window Parameters	O			
>Expected Propagation Delay	O		INTEGER (1..1200,…)	UL RTOA expected propagation delay as defined in TS 36.111 [9].
>Delay Uncertainty	O		INTEGER (1..100,…)	The uncertainty of the propagation delay. Mapping is included in TS 36.111 [9].
Number of Transmissions	M		INTEGER (1..500,…, 0)	The number of periodic SRS transmissions. The value of '0' represents an infinite number of SRS transmissions.
SRS Configuration	M	*<1.. maxServCell >*		Configuration of SRS for corresponding serving cells.
>PCI	M		INTEGER (0..503, …)	Physical Cell ID TS 36.455 [4].
>UL EARFCN	M		INTEGER (0..*maxEARFCN*, ...)	Corresponds to NUL for FDD and NDL/UL for TDD in ref. TS 36.104 [10]
>UL-bandwidth	M		ENUMERATED (n6, n15, n25, n50, n75, n100, ...)	Cell transmission bandwidth configuration in uplink corresponding to an E-UTRA channel bandwidth TS 36.104 [10], Table 5.6-1. Value n6 corresponds to 6 resource blocks, n15 to 15 resource blocks and so on.
>UL-CyclicPrefixLength	M		ENUMERATED (Normal, Extended)	Uplink cyclic prefix TS 36.455 [4].
>srs-BandwidthConfig	M		ENUMERATED (bw0, bw1, bw2, bw3, bw4, bw5, bw6, bw7, ...)	Cell-specific SRS bandwidth configuration TS 36.211 [11]. bw0 corresponds to value 0, bw1 to value 1 and so on.
>srs-Bandwidth	M		ENUMERATED (bw0, bw1, bw2, bw3, ...)	UE-specific SRS bandwidth configuration TS 36.211 [11]
>srs-AntennaPort	M		ENUMERATED (an1, an2, an4, , ...)	Number of antenna ports for SRS transmission. TS 36.211 [11]

>srs-HoppingBandwidth	M		ENUMERATED (hbw0, hbw1, hbw2, hbw3, ...)	SRS frequency hopping bandwidth configuration TS 36.211 [11]
>srs-cyclicShift	M		ENUMERATED (cs0, cs1, cs2, cs3, cs4, cs5, cs6, cs7, ...)	SRS-Cyclic shift [36.211]
>srs-ConfigIndex	M		INTEGER (0..1023)	SRS configuration index [TS 36.213]
>MaxUpPt	C-IfTDD		ENUMERATED (true)	*MaxUpPt* TS 36.211 [11]
>transmissionComb	M		INTEGER (0..1)	Transmission comb TS 36.211 [11]
>freqDomainPosition	M		INTEGER (0..23)	Frequency domain position TS 36.211 [11]
>groupHoppingEnabled	M		BOOLEAN	*Group-hopping-enabled* TS 36.211 [11]
>deltaSS	O		INTEGER (0..29)	*deltaSS* TS 36.211 [11]

Condition	Explanation
IfTDD	This IE shall be present if the *UL-EARFCN* IE refers to TDD operation.

Range bound	Explanation
maxServCell	Maximum number of serving cells = 5 TS 36.455 [4].
maxEARFCN	Maximum value of UL EARFCN. Value is 262143.

9.2.5 UL RTOA Measurements

The purpose of the *UL RTOA Measurements* IE is to signal UL RTOA measurement results to the E-SMLC.

IE/Group Name	Presence	Range	IE Type and Reference	Semantics Description
ULRTOAMeasurements	M	<0..*maxNoULRTOA*>		Information below included for each UL RTOA measurement.
>UL EARFCN	M		INTEGER (0..*maxEARFCN*,…)	Corresponds to NUL for FDD and NDL/UL for TDD in TS 36.104.
>UL RTOA	M		INTEGER (1..4800, …)	LU RTOA Measruement. Mapping of the measured quantity is as defined in TS 36.111 [9].

Range bound	Explanation
maxNoULRTOA	Maximum no. of UL RTOA measurements per UE is 5 , one measurement per carrier.
maxEARFCN	Maximum value of UL EARFCN. Value is 262143.

9.2.6 LMU ID

This information element represents the LMU ID to uniquely identify an LMU within an E-UTRAN.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
LMU ID	M		INTEGER (0..1048575)	

9.2.7 E-SMLC ID

This information element represents the E-SMLC ID to uniquely identify an E-SMLC.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
E-SMLC ID	M		INTEGER (0..255)	

9.2.8 LMU Information

This information element represents the LMU Capability information.

IE/Group Name	Presence	Range	IE type and reference	Semantics description
LMU Position	O		9.2.9	
ListofRFBands	M	*<1..maxNoLMURfBands.*		Information below included for each RF band supported
>FreqBandIndicator	M		INTEGER (1..256, ...)	Corresponds to E-UTRA Operating Band in TS 36.101 [5] Table 5.5-1.
BWCombinationParameters	O	*<1..maxBWComb>*		Applies for each UE in CA only. List of supported bandwidth combinations in which the LMU can perform UL RTOA measurements for UEs in CA.
>SupportedBandwidthCombinationSet	M		INTEGER (1..*maxBWCombSet)*	Supported bandwidth combination set as defined in 36.101.
>BandCombination	M	*<1 to maxSimultaneousBands>*		
>>FreqBandIndicator	M		INTEGER (1..256,...)	Corresponds to E-UTRA Operating Band in the corresponding CA bandwidth combination.

Range bound	Explanation
maxBWComb	Maximum no. of Band Combinations is 128.
maxBWCombSet	Maximum index of the bandwidth combination set is 32.
maxSimultaneousBands	Maximum number of Simultaneous Bands is 4.
maxNoLMURfBands	Maximum number of LMU RF Bands is 256.

9.2.9 LMU Position

LMU Position IE is used to identify the geographical position of an E-UTRAN LMU. It is expressed as ellipsoid point with altitude and uncertainty ellipsoid, with parameters according to TS 23.032 [6].

IE/Group Name	Presence	Range	IE Type and Reference	Semantics Description
Latitude Sign	M		ENUMERATED (North, South)	
Degrees Of Latitude	M		INTEGER (0..2^{23}-1)	
Degrees Of Longitude	M		INTEGER (-2^{23}..2^{23}-1)	
Direction of Altitude	M		ENUMERATED (Height, Depth)	
Altitude	M		INTEGER (0..2^{15}-1)	
Uncertainty semi-major	M		INTEGER (0..127)	
Uncertainty semi-minor	M		INTEGER (0..127)	
Orientation of major axis	M		INTEGER (0..179)	
Uncertainty Altitude	M		INTEGER (0..127)	
Confidence	M		INTEGER (0..100)	

9.2.10 Cause

The purpose of the *Cause* IE is to indicate the reason for a particular event for the SLmAP protocol.

IE/Group Name	Presence	Range	IE Type and Reference	Semantics Description
CHOICE *Cause Group*	M			
>Radio Network Layer				
>>Radio Network Layer Cause	M		ENUMERATED (Unknown or already allocated SLmAP ID, RF frequency bands not supported, RF bandwidth combination for a CA UE not supported, Invalid SRS configuration, Unspecified, …)	
>Protocol				
>>Protocol Cause	M		ENUMERATED (Transfer Syntax Error, Abstract Syntax Error (Reject), Abstract Syntax Error (Ignore and Notify), Message not Compatible with Receiver State, Semantic Error, Abstract Syntax Error (Falsely Constructed Message), Unspecified, …)	
>Misc				
>>Miscellaneous Cause	M		ENUMERATED (Control Processing Overload, Processing Resources not available, Hardware Failure, O&M Intervention, Unspecified, …)	

The meaning of the different cause values is described in the following tables. In general, "not supported" cause values indicate that the related capability is missing. On the other hand, "not available" cause values indicate that the related capability is present, but insufficient resources were available to perform the requested action.

Radio Network Layer cause	Meaning
Unknown or already allocated SLmAP ID	The action failed because the SLmAP ID is either unknown, or (for a first message received at the LMU) is known and already allocated to an existing context.
RF frequency bands not supported	The LMU does not support UL RTOA measurements in the requested RF band or RF band combinations for a CA UE.
RF bandwidth combination for a CA UE not supported	The LMU does not support UL RTOA measurements for a CA UE over the requested RF bandwidth or RF bandwidth combinations.
Invalid SRS configuration	The received SRS configuration for the target UE was not valid.
Unspecified	Sent when none of the above cause values applies but still the cause is Location Measurement related.

Protocol cause	Meaning
Transfer Syntax Error	The received message included a transfer syntax error.
Abstract Syntax Error (Reject)	The received message included an abstract syntax error and the concerning criticality indicated "reject".
Abstract Syntax Error (Ignore And Notify)	The received message included an abstract syntax error and the concerning criticality indicated "ignore and notify".
Message Not Compatible With LMU State	The received message was not compatible with the LMU state.
Semantic Error	The received message included a semantic error.
Abstract Syntax Error (Falsely Constructed Message)	The received message contained IEs or IE groups in wrong order or with too many occurrences.
Unspecified	Sent when none of the above cause values applies but still the cause is Protocol related.

Miscellaneous cause	Meaning
Control Processing Overload	Control processing overload.
Not Enough Processing Resources Available	No enough resources are available related to location processing.
Hardware Failure	Action related to hardware failure.
O&M Intervention	The action is due to O&M intervention.
Unspecified Failure	Sent when none of the above cause values applies and the cause is not related to either the Location Processing or Protocol categories.

9.2.11 Criticality Diagnostics

The *Criticality Diagnostics* IE is sent by the E-SMLC or the LMU when parts of a received message have not been comprehended or were missing, or if the message contained logical errors. When applicable, it contains information about which IEs were not comprehended or were missing. The conditions for inclusion of the SLmAP Transaction ID IE are described in clause 10.

For further details on how to use the *Criticality Diagnostics* IE, (see clause 10).

IE/Group Name	Presence	Range	IE type and reference	Semantics description
Procedure Code	O		INTEGER (0..63)	Procedure Code is to be used if Criticality Diagnostics is part of Error Indication procedure, and not within the response message of the same procedure that caused the error
Triggering Message	O		ENUMERATED(initiating message, successful outcome, unsuccessful outcome)	The Triggering Message is used only if the Criticality Diagnostics is part of Error Indication procedure.
Procedure Criticality	O		ENUMERATED(reject, ignore, notify)	This Procedure Criticality is used for reporting the Criticality of the Triggering message (Procedure).
SLmAP Transaction ID	O		9.2.3	
Information Element Criticality Diagnostics		*0 to <maxnoof errors>*		
>IE Criticality	M		ENUMERATED(reject, ignore, notify)	The IE Criticality is used for reporting the criticality of the triggering IE. The value 'ignore' shall not be used.
>IE ID	M		INTEGER (0..65535)	The IE ID of the not understood or missing IE
>Type of Error	M		ENUMERATED(not understood, missing, …)	

Range bound	Explanation
maxnooferrors	Maximum no. of IE errors allowed to be reported with a single message. The value for maxnooferrors is 256.

9.2.12 E-SMLC Measurement ID

The *E-SMLC Measurement ID* IE is used to associate all the procedures related to the same measurement initiated by the E-SMLC. Procedures related to the same measurement shall use the same E-SMLC Measurement ID.

The E-SMLC Measurement ID is determined by the initiating peer of the measurement i.e. the E-SMLC.

The E-SMLC Measurement ID shall uniquely identify a measurement among all ongoing parallel measurements initiated by the same peer.

IE/Group Name	Presence	Range	IE Type and Reference	Semantics Description
E-SMLC Measurement ID	M		INTEGER(1..65535, …)	

9.3 Message and Information Element Abstract Syntax (with ASN.1)

9.3.1 General

Sub clause 9.3 presents the Abstract Syntax of the SLmAP protocol with ASN.1. In case there is contradiction between the ASN.1 definition in this sub clause and the tabular format in sub clause 9.1 and 9.2, the ASN.1 shall take precedence, except for the definition of conditions for the presence of conditional elements, in which the tabular format shall take precedence.

The ASN.1 definition specifies the structure and content of SLmAP messages. SLmAP messages can contain any IEs specified in the object set definitions for that message without the order or number of occurrence being restricted by ASN.1. However, for this version of the standard, a sending entity shall construct a SLmAP message according to the PDU definitions module and with the following additional rules (Note that in the following IE means an IE in the object set with an explicit id. If one IE needed to appear more than once in one object set, then the different occurrences have different IE ids):

- IEs shall be ordered (in an IE container) in the order they appear in object set definitions.
- Object set definitions specify how many times IEs may appear. An IE shall appear exactly once if the presence field in an object has value "mandatory". An IE may appear at most once if the presence field in an object has value "optional" or "conditional". If in a tabular format there is multiplicity specified for an IE (i.e. an IE list) then in the corresponding ASN.1 definition the list definition is separated into two parts. The first part defines an IE container list in which the list elements reside. The second part defines list elements. The IE container list appears as an IE of its own. For this version of the standard an IE container list may contain only one kind of list elements.

If a SLmAP message that is not constructed as defined above is received, this shall be considered as Abstract Syntax Error, and the message shall be handled as defined for Abstract Syntax Error in clause 10.

9.3.2 Usage of Private Message Mechanism for Non-standard Use

The private message mechanism for non-standard use may be used:

- for special operator (and/or vendor) specific features considered not to be part of the basic functionality, i.e. the functionality required for a complete and high-quality specification in order to guarantee multivendor inter-operability.
- by vendors for research purposes, e.g. to implement and evaluate new algorithms/features before such features are proposed for standardisation.

The private message mechanism shall not be used for basic functionality. Such functionality shall be standardised.

9.3.3 Elementary Procedure Definitions

```
-- **************************************************************
--
-- Elementary Procedure definitions
--
-- **************************************************************

SLMAP-PDU-Descriptions {
itu-t (0) identified-organization (4) etsi (0) mobileDomain (0)
eps-Access (21) modules (3) slmap (50) version1 (1) slmap-PDU-Descriptions (0) }
```

```
DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

-- **************************************************************
--
-- IE parameter types from other modules.
--
-- **************************************************************

IMPORTS
    Criticality,
    ProcedureCode,
    SLMAPTransactionID

FROM SLMAP-CommonDataTypes


    ErrorIndication,
    PrivateMessage,
    SLMSetupRequest,
    SLMSetupResponse,
    SLMSetupFailure,
    MeasurementRequest,
    MeasurementResponse,
    MeasurementFailure,
    MeasurementUpdate,
    MeasurementAbort,
    ResetRequest,
    ResetAcknowledge

FROM SLMAP-PDU-Contents


    id-errorIndication,
    id-privateMessage,
    id-measurement,
    id-slmSetup,
    id-reset,
    id-measurementUpdate,
    id-measurementAbort

FROM SLMAP-Constants;


-- **************************************************************
--
-- Interface Elementary Procedure Class
--
-- **************************************************************

SLMAP-ELEMENTARY-PROCEDURE ::= CLASS {
```

```
    &InitiatingMessage              ,
    &SuccessfulOutcome                      OPTIONAL,
    &UnsuccessfulOutcome                    OPTIONAL,
    &procedureCode          ProcedureCode   UNIQUE,
    &criticality            Criticality     DEFAULT ignore
}
WITH SYNTAX {
    INITIATING MESSAGE      &InitiatingMessage
    [SUCCESSFUL OUTCOME     &SuccessfulOutcome]
    [UNSUCCESSFUL OUTCOME   &UnsuccessfulOutcome]
    PROCEDURE CODE          &procedureCode
    [CRITICALITY            &criticality]
}

-- **************************************************************
--
-- Interface PDU Definition
--
-- **************************************************************

SLMAP-PDU ::= CHOICE {
    initiatingMessage   InitiatingMessage,
    successfulOutcome   SuccessfulOutcome,
    unsuccessfulOutcome UnsuccessfulOutcome,
    ...
}

InitiatingMessage ::= SEQUENCE {
    procedureCode       SLMAP-ELEMENTARY-PROCEDURE.&procedureCode       ({SLMAP-ELEMENTARY-PROCEDURES}),
    criticality         SLMAP-ELEMENTARY-PROCEDURE.&criticality         ({SLMAP-ELEMENTARY-PROCEDURES}{@procedureCode}),
    slmapTransactionID  SLMAPTransactionID,
    value               SLMAP-ELEMENTARY-PROCEDURE.&InitiatingMessage   ({SLMAP-ELEMENTARY-PROCEDURES}{@procedureCode})
}

SuccessfulOutcome ::= SEQUENCE {
    procedureCode       SLMAP-ELEMENTARY-PROCEDURE.&procedureCode       ({SLMAP-ELEMENTARY-PROCEDURES}),
    criticality         SLMAP-ELEMENTARY-PROCEDURE.&criticality         ({SLMAP-ELEMENTARY-PROCEDURES}{@procedureCode}),
    slmapTransactionID  SLMAPTransactionID,
    value               SLMAP-ELEMENTARY-PROCEDURE.&SuccessfulOutcome   ({SLMAP-ELEMENTARY-PROCEDURES}{@procedureCode})
}

UnsuccessfulOutcome ::= SEQUENCE {
    procedureCode       SLMAP-ELEMENTARY-PROCEDURE.&procedureCode       ({SLMAP-ELEMENTARY-PROCEDURES}),
    criticality         SLMAP-ELEMENTARY-PROCEDURE.&criticality         ({SLMAP-ELEMENTARY-PROCEDURES}{@procedureCode}),
    slmapTransactionID  SLMAPTransactionID,
    value               SLMAP-ELEMENTARY-PROCEDURE.&UnsuccessfulOutcome ({SLMAP-ELEMENTARY-PROCEDURES}{@procedureCode})
}


-- **************************************************************
--
-- Interface Elementary Procedure List
--
-- **************************************************************
```

```
SLMAP-ELEMENTARY-PROCEDURES SLMAP-ELEMENTARY-PROCEDURE ::= {
    SLMAP-ELEMENTARY-PROCEDURES-CLASS-1        |
    SLMAP-ELEMENTARY-PROCEDURES-CLASS-2        ,
    ...
}

SLMAP-ELEMENTARY-PROCEDURES-CLASS-1 SLMAP-ELEMENTARY-PROCEDURE ::= {
    measurement                |
    slmSetup                   |
    reset                      ,
    ...
}

SLMAP-ELEMENTARY-PROCEDURES-CLASS-2 SLMAP-ELEMENTARY-PROCEDURE ::= {
    measurementUpdate              |
    measurementAbort               |
    errorIndication                |
    privateMessage                 ,
    ...
}


-- **************************************************************
--
-- Interface Elementary Procedures
--
-- **************************************************************

measurement             SLMAP-ELEMENTARY-PROCEDURE ::= {
    INITIATING MESSAGE      MeasurementRequest
    SUCCESSFUL OUTCOME      MeasurementResponse
    UNSUCCESSFUL OUTCOME    MeasurementFailure
    PROCEDURE CODE          id-measurement
    CRITICALITY             reject
}

slmSetup                    SLMAP-ELEMENTARY-PROCEDURE ::= {
    INITIATING MESSAGE      SLMSetupRequest
    SUCCESSFUL OUTCOME      SLMSetupResponse
    UNSUCCESSFUL OUTCOME    SLMSetupFailure
    PROCEDURE CODE          id-slmSetup
    CRITICALITY             reject
}

reset                       SLMAP-ELEMENTARY-PROCEDURE ::= {
    INITIATING MESSAGE      ResetRequest
    SUCCESSFUL OUTCOME      ResetAcknowledge
    PROCEDURE CODE          id-reset
    CRITICALITY             reject
}

measurementUpdate SLMAP-ELEMENTARY-PROCEDURE ::= {
    INITIATING MESSAGE      MeasurementUpdate
```

```
    PROCEDURE CODE          id-measurementUpdate
    CRITICALITY             ignore
}

measurementAbort        SLMAP-ELEMENTARY-PROCEDURE ::= {
    INITIATING MESSAGE      MeasurementAbort
    PROCEDURE CODE          id-measurementAbort
    CRITICALITY             ignore
}

errorIndication             SLMAP-ELEMENTARY-PROCEDURE ::= {
    INITIATING MESSAGE      ErrorIndication
    PROCEDURE CODE          id-errorIndication
    CRITICALITY             ignore
}

privateMessage              SLMAP-ELEMENTARY-PROCEDURE ::= {
    INITIATING MESSAGE      PrivateMessage
    PROCEDURE CODE          id-privateMessage
    CRITICALITY             ignore
}

END
```

9.3.4 PDU Definitions

```
-- **************************************************************
--
-- PDU definitions for SLmAP.
--
-- **************************************************************

SLMAP-PDU-Contents {
itu-t (0) identified-organization (4) etsi (0) mobileDomain (0)
eps-Access (21) modules (3) slmap (50) version1 (1) slmap-PDU-Contents (1) }

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

-- **************************************************************
--
-- IE parameter types from other modules.
--
-- **************************************************************

IMPORTS

    ESMLC-MeasurementID,
    UL-RTOAMeasurementConfiguration,
    CriticalityDiagnostics,
    UL-RTOAMeasurements,
    Cause,
    LMU-ID,
```

```
    LMUInformation,
    ESMLC-ID,
    ESMLC-MeasurementID

FROM SLMAP-IEs


    PrivateIE-Container{},
    ProtocolExtensionContainer{},
    ProtocolIE-Container{},
    ProtocolIE-ContainerList{},
    ProtocolIE-ContainerPair{},
    ProtocolIE-ContainerPairList{},
    ProtocolIE-Single-Container{},
    SLMAP-PRIVATE-IES,
    SLMAP-PROTOCOL-EXTENSION,
    SLMAP-PROTOCOL-IES,
    SLMAP-PROTOCOL-IES-PAIR
FROM SLMAP-Containers


    id-ESMLC-MeasurementID,
    id-UL-RTOAMeasurementConfiguration,
    id-CriticalityDiagnostics,
    id-UL-RTOAMeasurements,
    id-Cause,
    id-LMU-ID,
    id-LMUInformation,
    id-ESMLC-ID

FROM SLMAP-Constants;


-- **************************************************************
--
-- MEASUREMENT REQUEST
--
-- **************************************************************

MeasurementRequest ::= SEQUENCE {
    protocolIEs     ProtocolIE-Container        {{MeasurementRequest-IEs}},
    ...
}

MeasurementRequest-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-ESMLC-MeasurementID                 CRITICALITY reject  TYPE ESMLC-MeasurementID                    PRESENCE mandatory}|
    { ID id-UL-RTOAMeasurementConfiguration     CRITICALITY reject  TYPE UL-RTOAMeasurementConfiguration        PRESENCE mandatory},
    ...
}


-- **************************************************************
--
-- MEASUREMENT RESPONSE
```

```
--
-- **************************************************************

MeasurementResponse ::= SEQUENCE {
    protocolIEs     ProtocolIE-Container        {{MeasurementResponse-IEs}},
    ...
}

MeasurementResponse-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-ESMLC-MeasurementID         CRITICALITY reject  TYPE ESMLC-MeasurementID           PRESENCE mandatory}|
    { ID id-UL-RTOAMeasurements         CRITICALITY reject  TYPE UL-RTOAMeasurements           PRESENCE mandatory}|
    { ID id-CriticalityDiagnostics      CRITICALITY ignore  TYPE CriticalityDiagnostics        PRESENCE optional},
    ...
}


-- **************************************************************
--
-- MEASUREMENT FAILURE
--
-- **************************************************************

MeasurementFailure ::= SEQUENCE {
    protocolIEs                     ProtocolIE-Container        {{MeasurementFailure-IEs}},
    ...
}

MeasurementFailure-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-ESMLC-MeasurementID         CRITICALITY reject  TYPE ESMLC-MeasurementID           PRESENCE mandatory}|
    { ID id-Cause                       CRITICALITY ignore  TYPE Cause                         PRESENCE mandatory}|
    { ID id-CriticalityDiagnostics      CRITICALITY ignore  TYPE CriticalityDiagnostics        PRESENCE optional},
    ...
}


-- **************************************************************
--
-- SLM SETUP REQUEST
--
-- **************************************************************

SLMSetupRequest ::= SEQUENCE {
    protocolIEs                     ProtocolIE-Container        {{SLMSetupRequest-IEs}},
    ...
}

SLMSetupRequest-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-LMU-ID              CRITICALITY ignore  TYPE LMU-ID                PRESENCE mandatory}|
    { ID id-LMUInformation      CRITICALITY ignore  TYPE LMUInformation        PRESENCE optional},
    ...
}


-- **************************************************************
```

```
--
-- SLM SETUP RESPONSE
--
-- **************************************************************

SLMSetupResponse ::= SEQUENCE {
    protocolIEs                     ProtocolIE-Container        {{SLMSetupResponse-IEs}},
    ...
}

SLMSetupResponse-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-ESMLC-ID                    CRITICALITY reject  TYPE ESMLC-ID                       PRESENCE mandatory}|
    { ID id-CriticalityDiagnostics      CRITICALITY ignore  TYPE CriticalityDiagnostics         PRESENCE optional},
    ...
}


-- **************************************************************
--
-- SLM SETUP FAILURE
--
-- **************************************************************

SLMSetupFailure ::= SEQUENCE {
    protocolIEs                     ProtocolIE-Container        {{SLMSetupFailure-IEs}},
    ...
}

SLMSetupFailure-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-Cause                       CRITICALITY ignore  TYPE Cause                          PRESENCE mandatory}|
    { ID id-CriticalityDiagnostics      CRITICALITY ignore  TYPE CriticalityDiagnostics         PRESENCE optional},
    ...
}



-- **************************************************************
--
-- RESET REQUEST
--
-- **************************************************************

ResetRequest ::= SEQUENCE {
    protocolIEs                     ProtocolIE-Container        {{ResetRequest-IEs}},
    ...
}

ResetRequest-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-Cause               CRITICALITY ignore  TYPE Cause                  PRESENCE mandatory},
    ...
}


-- **************************************************************
```

```
--
-- RESET ACKNOWLEDGE
--
-- **************************************************************

ResetAcknowledge ::= SEQUENCE {
    protocolIEs                     ProtocolIE-Container        {{ResetAcknowledge-IEs}},
    ...
}

ResetAcknowledge-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-CriticalityDiagnostics      CRITICALITY ignore  TYPE CriticalityDiagnostics         PRESENCE optional},
    ...
}


-- **************************************************************
--
-- MEASUREMENT ABORT
--
-- **************************************************************

MeasurementAbort ::= SEQUENCE {
    protocolIEs                     ProtocolIE-Container        {{MeasurementAbort-IEs}},
    ...
}

MeasurementAbort-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-ESMLC-MeasurementID         CRITICALITY reject  TYPE ESMLC-MeasurementID            PRESENCE mandatory},
    ...
}


-- **************************************************************
--
-- MEASUREMENT UPDATE
--
-- **************************************************************

MeasurementUpdate ::= SEQUENCE {
    protocolIEs                     ProtocolIE-Container        {{ MeasurementUpdate-IEs}},
    ...
}

MeasurementUpdate-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-ESMLC-MeasurementID                 CRITICALITY reject  TYPE ESMLC-MeasurementID                    PRESENCE mandatory}|
    { ID id-UL-RTOAMeasurementConfiguration     CRITICALITY reject  TYPE UL-RTOAMeasurementConfiguration        PRESENCE mandatory},
    ...
}


-- **************************************************************
--
-- ERROR INDICATION
```

```
--
-- ********************************************************

ErrorIndication ::= SEQUENCE {
    protocolIEs                     ProtocolIE-Container        {{ErrorIndication-IEs}},
    ...
}

ErrorIndication-IEs SLMAP-PROTOCOL-IES ::= {
    { ID id-Cause                       CRITICALITY ignore  TYPE Cause                      PRESENCE optional}|
    { ID id-CriticalityDiagnostics      CRITICALITY ignore  TYPE CriticalityDiagnostics     PRESENCE optional},
    ...
}


-- ********************************************************
--
-- PRIVATE MESSAGE
--
-- ********************************************************

PrivateMessage ::= SEQUENCE {
    privateIEs      PrivateIE-Container  {{PrivateMessage-IEs}},
    ...
}

PrivateMessage-IEs SLMAP-PRIVATE-IES ::= {
    ...
}

END
```

9.3.5 Information Element definitions

```
-- ********************************************************
--
-- Information Element Definitions
--
-- ********************************************************

SLMAP-IEs {
itu-t (0) identified-organization (4) etsi (0) mobileDomain (0)
eps-Access (21) modules (3) slmap (50) version1 (1) slmap-IEs (2) }

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS

    maxNrOfErrors,
    maxServCell,
    maxEARFCN,
```

```
    maxNoULRTOA,
    maxNoLMURfBands,
    maxBWCombSet,
    maxBWComb,
    maxSimultaneousBands

FROM SLMAP-Constants

    Criticality,
    SLMAPTransactionID,
    ProcedureCode,
    ProtocolIE-ID,
    TriggeringMessage
FROM SLMAP-CommonDataTypes

    ProtocolExtensionContainer{},
    ProtocolIE-Single-Container{},
    SLMAP-PROTOCOL-EXTENSION,
    SLMAP-PROTOCOL-IES
FROM SLMAP-Containers;


Cause ::= CHOICE {
    radioNetworkLayer   RadioNetworkLayerCause,
    protocol            ProtocolCause,
    misc                MiscCause,
    ...
}

RadioNetworkLayerCause::= ENUMERATED {
    unknown-or-already-allocated-slmap-id,
    rf-frequency-band-not-supported,
    rf-bandwidth-not-supported,
    invalid-srs-coniguration,
    unspecified,
    ...
}

ProtocolCause ::= ENUMERATED {
    transfer-syntax-error,
    abstract-syntax-error-reject,
    abstract-syntax-error-ignore-and-notify,
    message-not-compatible-with-receiver-state,
    semantic-error,
    abstract-syntax-error-falsely-constructed-message,
    unspecified,
    ...
}

MiscCause ::= ENUMERATED {
    control-processing-overload,
    processing-resources-not-available,
    hardware-failure,
    o-and-m-intervention,
```

```
    unspecified,
    ...
}


CriticalityDiagnostics ::= SEQUENCE {
    procedureCode                   ProcedureCode                                                   OPTIONAL,
    triggeringMessage               TriggeringMessage                                               OPTIONAL,
    procedureCriticality            Criticality                                                     OPTIONAL,
    slmapTransactionID              SLMAPTransactionID                                              OPTIONAL,
    iEsCriticalityDiagnostics       CriticalityDiagnostics-IE-List                                  OPTIONAL,
    iE-Extensions                   ProtocolExtensionContainer { {CriticalityDiagnostics-ExtIEs} }  OPTIONAL,
    ...
}


CriticalityDiagnostics-ExtIEs SLMAP-PROTOCOL-EXTENSION ::= {
    ...
}

CriticalityDiagnostics-IE-List ::= SEQUENCE (SIZE (1..maxNrOfErrors)) OF
    SEQUENCE {
        iECriticality           Criticality,
        iE-ID                   ProtocolIE-ID,
        typeOfError             TypeOfError,
        iE-Extensions           ProtocolExtensionContainer { {CriticalityDiagnostics-IE-List-ExtIEs} } OPTIONAL,
        ...
}

CriticalityDiagnostics-IE-List-ExtIEs SLMAP-PROTOCOL-EXTENSION ::= {
    ...
}

TypeOfError ::= ENUMERATED {
    not-understood,
    missing,
    ...
}



UL-RTOAMeasurementConfiguration ::= SEQUENCE {
    ulRtoaReferenceTime         BIT STRING (SIZE (64)),
    searchWindowParameters      SearchWindowParameters                  OPTIONAL,
    numberOfTransmissions       INTEGER (1..500,..., 0),
    srsConfiguration            SRSConfiguration,
    ...
}

SearchWindowParameters ::= SEQUENCE {
    expectedPropagationDelay    INTEGER (1..1200, ...)                  OPTIONAL,
    delayUncertainty            INTEGER (1..100, ...)                   OPTIONAL,
    ...
}
```

```
SRSConfiguration ::= SEQUENCE (SIZE (1.. maxServCell)) OF SRSConfigurationForOneCell

SRSConfigurationForOneCell ::= SEQUENCE {
    pci                         PCI,
    ulEarfcn                    EARFCN,
    ulBandwidth                 ChannelBandwidth,
    ulCyclicPrefixLength        CPLength,
    srsBandwidthConfig          BandwidthConfig,
    srsBandwidth                SRSBandwidth,
    srsAntennaPort              AntennaPort,
    srsHoppingBandwidth         HoppingBandwidth,
    srsCyclicShift              CyclicShift,
    srsConfigIndex              INTEGER (0..1023),
    srsMaxUpPts                 ENUMERATED {true}           OPTIONAL, -- present if TDD
    transmissionComb            INTEGER (0..1),
    freqDomainPosition          INTEGER (0..23),
    groupHoppingEnabled         BOOLEAN,
    deltaSS                     INTEGER (0..29)         OPTIONAL,
    ...
}

PCI ::= INTEGER (0..503, ...)

EARFCN ::= INTEGER (0..maxEARFCN, ...)

ChannelBandwidth ::= ENUMERATED {
    n6,
    n15,
    n25,
    n50,
    n75,
    n100,
    ...
}

CPLength ::= ENUMERATED {
    normal,
    extended,
    ...
}

BandwidthConfig ::= ENUMERATED {
    bw0,
    bw1,
    bw2,
    bw3,
    bw4,
    bw5,
    bw6,
    bw7,
    ...
}
```

```
SRSBandwidth ::= ENUMERATED {
    bw0,
    bw1,
    bw2,
    bw3,
    ...
}

AntennaPort ::= ENUMERATED {
    an1,
    an2,
    an4,
    ...
}

HoppingBandwidth ::= ENUMERATED {
    hbw0,
    hbw1,
    hbw2,
    hbw3,
    ...
}

CyclicShift ::= ENUMERATED {
    cs0,
    cs1,
    cs2,
    cs3,
    cs4,
    cs5,
    cs6,
    cs7,
    ...
}


UL-RTOAMeasurements ::= SEQUENCE (SIZE (1.. maxNoULRTOA)) OF UL-RTOAMeasurement

UL-RTOAMeasurement ::= SEQUENCE {
    ulEarfcn                    EARFCN,
    ulRtoa                      INTEGER (1.. 4800, ...),
    ...
}

LMU-ID ::= INTEGER (0..1048575)

ESMLC-ID ::= INTEGER (0..255)

ESMLC-MeasurementID ::= INTEGER (0.. 65535, ...)


LMUInformation ::= SEQUENCE {
    lmuPosition                 LMUPosition                     OPTIONAL,
    listOfRfBands               ListOfRfBands,
```

```
    bWCombinationParameters     BWCombinationParameters         OPTIONAL,
    ...
}

ListOfRfBands ::= SEQUENCE (SIZE (1.. maxNoLMURfBands)) OF FreqBandIndicator

FreqBandIndicator ::= INTEGER (1.. 256)

BWCombinationParameters ::= SEQUENCE (SIZE (1.. maxBWComb)) OF
    SupportedBandwidthCombinationSet


SupportedBandwidthCombinationSet ::= SEQUENCE (SIZE (1.. maxBWCombSet)) OF
    BandCombination



BandCombination ::= SEQUENCE (SIZE (1.. maxSimultaneousBands)) OF
    FreqBandIndicator

LMUPosition ::= SEQUENCE {
    latitudeSign                ENUMERATED {north, south},
    latitude                    INTEGER (0..8388607),
    longitude                   INTEGER (-8388608..8388607),
    directionOfAltitude         ENUMERATED {height, depth},
    altitude                    INTEGER (0..32767),
    uncertaintySemi-major       INTEGER (0..127),
    uncertaintySemi-minor       INTEGER (0..127),
    orientationOfMajorAxis      INTEGER (0..179),
    uncertaintyAltitude         INTEGER (0..127),
    confidence                  INTEGER (0..100),
    ...
}

END
```

9.3.6 Common definitions

```
-- **************************************************************
--
-- Common definitions
--
-- **************************************************************

SLMAP-CommonDataTypes {
itu-t (0) identified-organization (4) etsi (0) mobileDomain (0)
eps-Access (21) modules (3) slmap (50) version1 (1) slmap-CommonDataTypes (3)  }

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN
```

```
-- ************************************************************
--
-- Extension constants
--
-- ************************************************************

maxPrivateIEs                                   INTEGER ::= 65535
maxProtocolExtensions                           INTEGER ::= 65535
maxProtocolIEs                                  INTEGER ::= 65535

-- ************************************************************
--
-- Common Data Types
--
-- ************************************************************

Criticality     ::= ENUMERATED { reject, ignore, notify }

SLMAPTransactionID      ::= INTEGER (0..32767, ...)

Presence        ::= ENUMERATED { optional, conditional, mandatory }

PrivateIE-ID    ::= CHOICE {
    local               INTEGER (0.. maxPrivateIEs),
    global              OBJECT IDENTIFIER
}

ProcedureCode       ::= INTEGER (0..63)

ProtocolIE-ID       ::= INTEGER (0..maxProtocolIEs)

TriggeringMessage   ::= ENUMERATED { initiating-message, successful-outcome, unsuccessful-outcome}

END
```

9.3.7 Constant definitions

```
-- ************************************************************
--
-- Constant definitions
--
-- ************************************************************

SLMAP-Constants {
itu-t (0) identified-organization (4) etsi (0) mobileDomain (0)
eps-Access (21) modules (3) slmap (50) version1 (1) slmap-Constants (4) }

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

IMPORTS
```

```
    ProcedureCode,
    ProtocolIE-ID
FROM SLMAP-CommonDataTypes;


-- ************************************************************
--
-- Elementary Procedures
--
-- ************************************************************

id-errorIndication                      ProcedureCode ::= 0
id-privateMessage                       ProcedureCode ::= 1
id-measurement                          ProcedureCode ::= 2
id-slmSetup                             ProcedureCode ::= 3
id-reset                                ProcedureCode ::= 4
id-measurementUpdate                    ProcedureCode ::= 5
id-measurementAbort                     ProcedureCode ::= 6


-- ************************************************************
--
-- Lists
--
-- ************************************************************

maxNrOfErrors                           INTEGER ::= 256
maxServCell                             INTEGER ::= 5
maxEARFCN                               INTEGER ::= 262143
maxNoULRTOA                             INTEGER ::= 5
maxNoLMURfBands                         INTEGER ::= 256
maxBWComb                               INTEGER ::= 128
maxBWCombSet                            INTEGER ::= 32
maxSimultaneousBands                    INTEGER ::= 4


-- ************************************************************
--
-- IEs
--
-- ************************************************************

id-ESMLC-MeasurementID                  ProtocolIE-ID ::= 0
id-UL-RTOAMeasurementConfiguration      ProtocolIE-ID ::= 1
id-CriticalityDiagnostics               ProtocolIE-ID ::= 2
id-UL-RTOAMeasurements                  ProtocolIE-ID ::= 3
id-Cause                                ProtocolIE-ID ::= 4
id-LMU-ID                               ProtocolIE-ID ::= 5
id-LMUInformation                       ProtocolIE-ID ::= 6
id-ESMLC-ID                             ProtocolIE-ID ::= 7

END
```

9.3.8 Container definitions

```
-- **************************************************************
--
-- Container definitions
--
-- **************************************************************

SLMAP-Containers {
itu-t (0) identified-organization (4) etsi (0) mobileDomain (0)
eps-Access (21) modules (3) slmap (50) version1 (1) slmap-Containers (5) }

DEFINITIONS AUTOMATIC TAGS ::=

BEGIN

-- **************************************************************
--
-- IE parameter types from other modules.
--
-- **************************************************************

IMPORTS
    maxPrivateIEs,
    maxProtocolExtensions,
    maxProtocolIEs,
    Criticality,
    Presence,
    PrivateIE-ID,
    ProtocolIE-ID
FROM SLMAP-CommonDataTypes;

-- **************************************************************
--
-- Class Definition for Protocol IEs
--
-- **************************************************************

SLMAP-PROTOCOL-IES ::= CLASS {
    &id             ProtocolIE-ID           UNIQUE,
    &criticality    Criticality,
    &Value,
    &presence       Presence
}
WITH SYNTAX {
    ID              &id
    CRITICALITY     &criticality
    TYPE            &Value
    PRESENCE        &presence
}

-- **************************************************************
--
```

```
-- Class Definition for Protocol IEs
--
-- ************************************************************

SLMAP-PROTOCOL-IES-PAIR ::= CLASS {
    &id                     ProtocolIE-ID       UNIQUE,
    &firstCriticality       Criticality,
    &FirstValue,
    &secondCriticality      Criticality,
    &SecondValue,
    &presence               Presence
}
WITH SYNTAX {
    ID                      &id
    FIRST CRITICALITY       &firstCriticality
    FIRST TYPE              &FirstValue
    SECOND CRITICALITY      &secondCriticality
    SECOND TYPE             &SecondValue
    PRESENCE                &presence
}

-- ************************************************************
--
-- Class Definition for Protocol Extensions
--
-- ************************************************************

SLMAP-PROTOCOL-EXTENSION ::= CLASS {
    &id                 ProtocolIE-ID       UNIQUE,
    &criticality        Criticality,
    &Extension,
    &presence           Presence
}
WITH SYNTAX {
    ID                  &id
    CRITICALITY         &criticality
    EXTENSION           &Extension
    PRESENCE            &presence
}

-- ************************************************************
--
-- Class Definition for Private IEs
--
-- ************************************************************

SLMAP-PRIVATE-IES ::= CLASS {
    &id                 PrivateIE-ID,
    &criticality        Criticality,
    &Value,
    &presence           Presence
}
WITH SYNTAX {
    ID                  &id
```

```
    CRITICALITY         &criticality
    TYPE                &Value
    PRESENCE            &presence
}

-- **************************************************************
--
-- Container for Protocol IEs
--
-- **************************************************************

ProtocolIE-Container { SLMAP-PROTOCOL-IES : IEsSetParam} ::=
    SEQUENCE (SIZE (0..maxProtocolIEs)) OF
    ProtocolIE-Field {{IEsSetParam}}

ProtocolIE-Single-Container { SLMAP-PROTOCOL-IES : IEsSetParam} ::=
    ProtocolIE-Field {{IEsSetParam}}

ProtocolIE-Field { SLMAP-PROTOCOL-IES : IEsSetParam} ::= SEQUENCE {
    id              SLMAP-PROTOCOL-IES.&id                  ({IEsSetParam}),
    criticality     SLMAP-PROTOCOL-IES.&criticality         ({IEsSetParam}{@id}),
    value           SLMAP-PROTOCOL-IES.&Value               ({IEsSetParam}{@id})
}

-- **************************************************************
--
-- Container for Protocol IE Pairs
--
-- **************************************************************

ProtocolIE-ContainerPair { SLMAP-PROTOCOL-IES-PAIR : IEsSetParam} ::=
    SEQUENCE (SIZE (0..maxProtocolIEs)) OF
    ProtocolIE-FieldPair {{IEsSetParam}}

ProtocolIE-FieldPair { SLMAP-PROTOCOL-IES-PAIR : IEsSetParam} ::= SEQUENCE {
    id                  SLMAP-PROTOCOL-IES-PAIR.&id                 ({IEsSetParam}),
    firstCriticality    SLMAP-PROTOCOL-IES-PAIR.&firstCriticality   ({IEsSetParam}{@id}),
    firstValue          SLMAP-PROTOCOL-IES-PAIR.&FirstValue         ({IEsSetParam}{@id}),
    secondCriticality   SLMAP-PROTOCOL-IES-PAIR.&secondCriticality  ({IEsSetParam}{@id}),
    secondValue         SLMAP-PROTOCOL-IES-PAIR.&SecondValue        ({IEsSetParam}{@id})
}

-- **************************************************************
--
-- Container Lists for Protocol IE Containers
--
-- **************************************************************

ProtocolIE-ContainerList {INTEGER : lowerBound, INTEGER : upperBound, SLMAP-PROTOCOL-IES : IEsSetParam} ::=
    SEQUENCE (SIZE (lowerBound..upperBound)) OF
    ProtocolIE-Container {{IEsSetParam}}

ProtocolIE-ContainerPairList {INTEGER : lowerBound, INTEGER : upperBound, SLMAP-PROTOCOL-IES-PAIR : IEsSetParam} ::=
    SEQUENCE (SIZE (lowerBound..upperBound)) OF
```

```
    ProtocolIE-ContainerPair {{IEsSetParam}}

-- **************************************************************
--
-- Container for Protocol Extensions
--
-- **************************************************************

ProtocolExtensionContainer { SLMAP-PROTOCOL-EXTENSION : ExtensionSetParam} ::=
    SEQUENCE (SIZE (1..maxProtocolExtensions)) OF
    ProtocolExtensionField {{ExtensionSetParam}}

ProtocolExtensionField { SLMAP-PROTOCOL-EXTENSION : ExtensionSetParam} ::= SEQUENCE {
    id                  SLMAP-PROTOCOL-EXTENSION.&id            ({ExtensionSetParam}),
    criticality         SLMAP-PROTOCOL-EXTENSION.&criticality   ({ExtensionSetParam}{@id}),
    extensionValue      SLMAP-PROTOCOL-EXTENSION.&Extension     ({ExtensionSetParam}{@id})
}

-- **************************************************************
--
-- Container for Private IEs
--
-- **************************************************************

PrivateIE-Container { SLMAP-PRIVATE-IES : IEsSetParam} ::=
    SEQUENCE (SIZE (1..maxPrivateIEs)) OF
    PrivateIE-Field {{IEsSetParam}}

PrivateIE-Field { SLMAP-PRIVATE-IES : IEsSetParam} ::= SEQUENCE {
    id              SLMAP-PRIVATE-IES.&id               ({IEsSetParam}),
    criticality     SLMAP-PRIVATE-IES.&criticality      ({IEsSetParam}{@id}),
    value           SLMAP-PRIVATE-IES.&Value            ({IEsSetParam}{@id})
}

END
```

9.4 Message Transfer Syntax

SLmAP shall use the ASN.1 Basic Packed Encoding Rules (BASIC-PER) Aligned Variant as transfer syntax as specified in ref. ITU-T Rec. X.691 [8].

9.5 Timers

Void.

10 Handling of Unknown, Unforeseen and Erroneous Protocol Data

Section 10 of TS 36.413 [7] is applicable for the purposes of the present document, with the following additions:

- In case of Abstract Syntax Error, when reporting the *Criticality Diagnostics* IE for not comprehended IE/IE groups or missing IE/IE groups, the *SLmAP Transaction ID* IE shall also be included;
- In case of Logical Error, when reporting the *Criticality Diagnostics* IE, the *SLmAP Transaction ID* IE shall also be included.

Annex A (informative): Change history

Change history						
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	New
2012-12	58	RP-121769			Approved in RAN#58 and put under change control	11.0.0
2013-03	59	RP-130209	0001	-	Correction on Setup and Reset	11.1.0
2013-03	59	RP-130237	0002	1	Extending maxEARFCN	11.1.0
2013-03	59	RP-130209	0003	1	NBPS in LTE, UL RTOA Measurement Configuration in Measurement Request	11.1.0
2013-03	59	RP-130316	0004	-	NBPS in LTE, Identifier for SLmAP	11.1.0
2013-06	60	RP-130642	0005	3	Abnormal Conditions for Reset	11.2.0
2013-09	61	RP-131182	0006	1	Correction on Measurement Abort	11.3.0
2013-09	61	RP-131182	0007	1	Correction on Measurement Update	11.3.0
2013-09	61	RP-131182	0008	1	ASN.1 correction Section 9.3.5 UL-RTOA Measurement Configuration	11.3.0
2014-09					Update to Rel-12 version (MCC)	12.0.0
2015-03	67	RP-150356	0009	-	Correction of Error Indication	12.1.0
2015-12					Update to Rel-13 version (MCC)	13.0.0
2016-03	71	RP-160449	0010	-	Correction of tabular for Procedure Code in the Message Type IE	13.1.0

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2017-03	SA#75					Promotion to Release 14 without technical change	14.0.0
2018-06	SA#80	-	-	-	-	Promotion to Release 15 without technical change	15.0.0

History

Document history		
V15.0.0	July 2018	Publication