Technical Document

G23-GSM PROTOCOL STACK

E-OTD SYSTEM ARCHITECTURE

HIGH LEVEL DESIGN SPECIFICATION

Document Number:	8443.713.02.100
Version:	0.7
Status:	Draft
Approval Authority:	
Creation Date:	2002-Jun-07
Last changed:	2015-Mar-08 by XGUTTEFE
File Name:	8443_713_02_EOTD_SystemArchitecture.doc

Important Notice

Texas Instruments Incorporated and/or its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products, software and services at any time and to discontinue any product, software or service without notice. Customers should obtain the latest relevant information during product design and before placing orders and should verify that such information is current and complete.

All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment. TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI products, software and/or services. To minimize the risks associated with customer products and applications, customers should provide adequate design, testing and operating safeguards.

Any access to and/or use of TI software described in this document is subject to Customers entering into formal license agreements and payment of associated license fees. TI software may solely be used and/or copied subject to and strictly in accordance with all the terms of such license agreements.

Customer acknowledges and agrees that TI products and/or software may be based on or implement industry recognized standards and that certain third parties may claim intellectual property rights therein. The supply of products and/or the licensing of software does not convey a license from TI to any third party intellectual property rights and TI expressly disclaims liability for infringement of third party intellectual property rights.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products, software or services are used.

Information published by TI regarding third–party products, software or services does not constitute a license from TI to use such products, software or services or a warranty, endorsement thereof or statement regarding their availability. Use of such information, products, software or services may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Change History

Date	Changed by	Approved by	Version	Status	Notes
2002-Jun-07	OT		0.1	Being Processed	1
2002-Jun-07	OTH		0.2	Being Processed	
2002-Jun-07	OTH		0.3	Being Processed	
2002-Aug-28	OTH		0.4	Being Processed	
2002-Aug-30	OTH		0.5	Being	

				Processed	
2002-Sep-30	OTH		0.6	Accepted	
2003-May-08	XGUTTEFE		0.7	Draft	

Notes:

1. Initial version

Table of Contents

List of Figures and Tables

List of References

[ISO 9000:2000] International Organization for Standardization. Quality management systems - Fundamentals and vocabulary. December 2000

1.1 References

[3GPP_03.71] Digital cellular telecommunications system (Phase 2+), Location services (LCS), (Functional description) - Stage 2, (V8.5.0 Release 1999)

[3GPP_04.18] 3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Mobile radio interface layer 3 specification, Radio Resource Control Protocol, (V8.13.0 Release 1999)

[3GPP_04.31] 3rd Generation Partnership Project; Technical Specification Group GSM EDGE Radio Access Network; Location Services (LCS); Mobile Station (MS) – Serving Mobile Location Centre (SMLC); Radio Resource LCS Protocol (RRLP), (V8.8.0 Release 1999)

[3GPP_24.007] 3rd Generation Partnership Project; Technical Specification Group Core Network; Mobile radio interface signalling layer 3; (V3.8.0 Release 1999)

[3GPP_24.030] 3rd Generation Partnership Project; Technical Specification Group Core Network; Location Services (LCS); Supplementary service operations - Stage 3), (V3.3.0 Release 1999)

[3GPP_22.071] 3rd Generation Partnership Project; Technical Specification Group services and System aspects; Location services (LCS); Service description; Stage 1 (V3.4.0 Release 1999)

http://www.fcc.gov/911/enhanced/ For further information of E911 requirements.

[X.209] ITU-T Recommendation X.209: "Specification of Abstract Syntax Notation One (ASN.1)

[CU 0107] CPS - GSM Cursor™ Mobile Terminal Requirements, Full Specification – Issue 4.2

[CU 0115] CPS - GSM Cursor™ Mobile Terminal Requirements, MMI Specification – Issue 1.1

[CU 0126] CPS - GSM Cursor™ Mobile Terminal Requirements, AT Commands for Feature Control – Issue 3.3

[CU 0149] CPS - GSM Cursor™ Enhanced Observed Time Difference, (Software implementation project) – Issue 3.0

[CU 0305] CPS - GSM Cursor™ Mobile Terminal Requirements, Cursor™ Task Bridge Description – Issue 1.3

[TI S922] L1/RR interface for neighbour cells monitoring (Idle mode) and EOTD

[8353.507] UELCS Requirements for Location Services in a UE – Requirement Analysis

[4711.005.02] G23-GPRS Protocol Stack Release 1.4.0, Product Specification, May 2002

[4711.020.02] G23-GPRS Protocol, E-OTD Lower Level Design LC, August 2002

[4711.021.02] G23-GPRS Protocol, E-OTD Lower Level Design RR, August 2002

[TI 7010.801] 7010.801, References and Vocabulary, Texas Instruments

[C_7010.801] 7010.801, References and Vocabulary, Condat AG

1.2 Abbreviations

ACI	Application Control Interface (AT Commands)
AL	Application Layer
APDU	Application Protocol Data Unit
CBCH	Common Broadcast CHannel
CPS	Cambridge Positioning System
DTAP	Direct Transfer Application Part
E-OTD	Enhanced Observed Time Difference positioning method
LCS	Location Services
LC	Location Service handling Entity
LR	Location Request
NA-ESRD	North American Emergency Services Routing Digits
NA-ESRK	North American Emergency Services Routing Key
PS	Protocol Stack
RRLP	Radio Resource Location Service Protocol
SMLC	Serving Mobile Location Center

1.3 Definitions

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

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

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

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

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

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

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

Privacy Class: A list of permissions which may be granted to the LCS to locate the target MS.

APDU: An APDU for LCS contains an RRLP message of up to 251 bytes, which is the maximum size for an RRLP segment.

2 Summary

This document specifies the software architecture impacts for implementing E-OTD as a Location Services (LCS) in a MS. E-OTD is based on extensive measurements of the neighbouring cells and the serving cell. These measurements are processed in a specific module (Cursor™ task) provided by a third party vendor, Cambridge Positioning Systems (CPS). The Cursor ™ software supports a MS-assisted E-OTD implementation, all required measurements are done inside the MS but the location computation is done in the network (SMLC). The positioning data will be transferred to the network with the new RR Location Service Protocol (RRLP). Neither a MS-based nor a GPS implementation is inside the scope of this document. Even though these features have been taken into account for the design phase.

The full MS-assisted E-OTD implementation consists of the basic functionality required to fulfil FCC E911 rules and an add-on based on supplementary service functionality needed for Location Based Services.

In order to assist the measurement acquisition, the MS may use location assistance data subsequently. These data is sent to the MS as part of the position request via the RRLP. The ciphering key enables the MS to de-cipher general location Assistance Data broadcast periodically by the network via CBCH. This information is only processed in case of a MS-based E-OTD implementation and therefore no requirements results for the first implementation.

The stage 1 description of LCS can be found in [3G TS22.071]

A detailed description of the Location Services can be found in ref [GSM 03.71] section 7.6.6.

This document is based on the G23-GPRS Protocol Stack Release 1.4.0 Product Specification and does not take any UMTS implementations into account. Still an upgrade to the UMTS PS is planned and will be implemented in the course of the Dual Mode project.

The Message sequence charts for the different types of Location Service operations can be found in Annex B.

3 Introduction

The E-OTD method is based on measurements in the MS of the Enhanced Observed Time Difference of arrival of burst from some known BTSs. Therefore this is a 'mobile assisted' method. In addition to this it can also be a 'mobile based' method if the location calculation is carried out inside the handset. For a successful position calculation it is necessary that at least three geographically dispersed BTSs are audible by the MS. An extra network component 'LMU' does radio measurements to support LCS by measurement of the Real Time Difference (RTD) of pairs of (unsynchronized) BTSs.

Based on the measured E-OTD values the location of MS can be calculated either in the network or in the MS itself. The latter of course only if all the needed information is available in the MS (BTSs location co-ordinates, their RTDs etc.). Regarding this case so called Assistance Data are necessary which can be conveyed using the RRLP.
In general there are three types of initiation of location service operation available:

- Network Induced Location Request (NI-LR), and
- Mobile Terminated Location Request (MT-LR), and
- Mobile Originated Location Request (MO-LR)

The first solution (NI-LR) is mainly used for Emergency Call service but can also utilized for other kinds of Location Service. MT-LR and MO-LR both access the Location Service using the call independent Supplementary Service. The Supplementary Service is used for privacy verification as well as requesting own location, location assistance data or broadcast assistance data message ciphering keys from the network. The target MS notifies the MS user of the location request and, if privacy verification was requested by the user, the target MS indicates whether the location request will be allowed or not allowed in the absence of a response and waits for the user to grant or withhold permission. The ciphering key enables the MS to decipher location assistance data broadcast periodically by the network (CBCH).

The MSCs in Annex B do not claim sufficiency; in fact they qualify a straightforward solution for clarifying the primitive exchange between the entities. The intention is to illustrate the solution proposal and not to replace the detailed lower level design specification.

As this document specifies the actions needed for implementing E-OTD for Emergency Calls an implementation for switching on/off LCS functionality in the MMI is out of scope of this document. The calculation algorithm and the additional measurements are started at powering on the phone and runs continuously.

3.1 Assistance Data

As adumbrated before there are two different kinds of assistance data:

- Point to point assistance data transported via RRLP
- Point to multipoint assistance data transported via CBCH

The first one is used for all different LCS implementation in case of a concrete position request where the latter one is used for MS-based E-OTD, MS-based GPS and MS-assisted GPS for position maintaining during normal operation. Table 2 lists the usage of the different assistance data dependent of the LCS implementation (the grey marked column indicates the kind of assistance data needed for MS-assisted E-OTD).

	Assistance Data – RRLP	Assistance Data - CBCH
MS-assisted E-OTD	✓	-
MS-based E-OTD	✓	✓
MS-assisted GPS	✓	✓
MS-based GPS	✓	✓

Table 1: List of different assistance data and their usage

3.2 Entity RRLP

The Radio Resource LCS Protocol (RRLP) is a local application to RR. The RRLP entity allows Application Protocol Data Units (APDUs) to be transferred between the peer entities in the SMLC and the MS. An APDU for LCS will contain an RRLP message of up to 251 bytes, which is the maximum size for an RRLP segment. In case of an RRLP message with a size bigger than 251 bytes, segmentation is applicable for either direction of transfer.

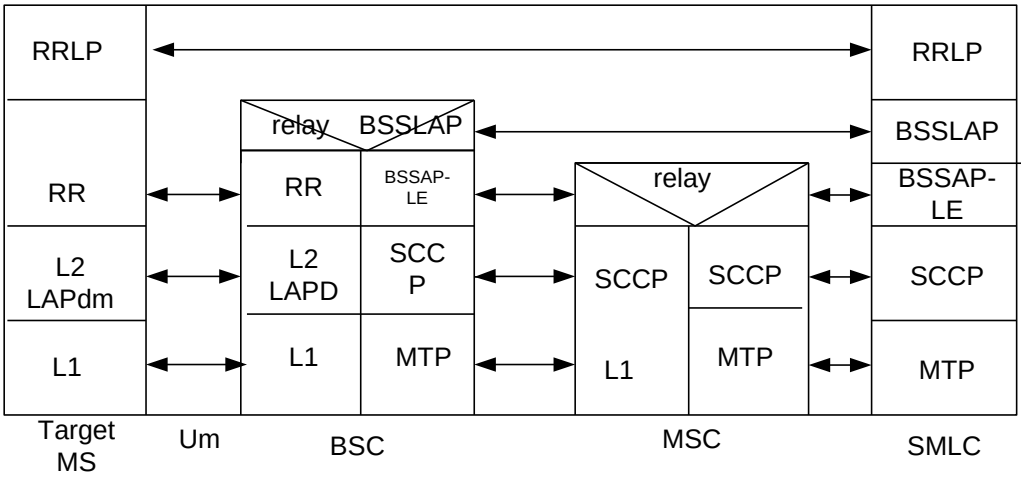


Figure 1: Protocol layers between the MS and the SMLC, using the SDCCH or FACCH (TS 03.71)

Using the Radio Resource LCS Protocol (RRLP), LCS related information can be transferred between the MS and the Serving Mobile Location Center (SMLC). The SMLC decides if assistance data is necessary for the MS, and then requests the MS to perform E-OTD or GPS measurements, which are then transferred back to the SMLC.

4 E-OTD System Structure

4.1 Feasibility Studies

The biggest impacts on the existing PS are the changes in RR, especially changing the cell reselection. The Cursor ™ tasks needs the measurement data taken from the serving cell and up to 12 neighbour cells every 10 seconds. As required in the 3GPP specification the PS currently provides the data for up to 6 neighbour cells every 30 seconds. With the existing implementation the requirements from CPS cannot be fulfilled. Therefore a new design is needed which fulfils the CPS requirements on one hand but is still able to operate in the 30 second cycle in case E-OTD is not requested in a product. A detailed figure can be found in Annex A.

Implementing a LC controller as an interface from the LCS functionality to the involved entities and the processing blocks inside the LC module creates a more generic approach to enable further LCS implementations, e.g. MS-based E-OTD or GPS, without changing the interface towards the involved entities.

Supporting only Emergency Service calls in the first implementation and extends this functionality with supplementary service features in the second step gains time, resources and testing effort. This needs to be agreed with customers and network operators.

A very important point towards the whole integration procedure is the testing strategy. CPS is stating that they support the software integration and testing during the whole procedure. Phase one is the laboratory test phase at the manufacture's site using their E-OTD handset test system. The laboratory validation phase will take place at the CPS' handset facility, using their E-OTD handset test system. The system test will be performed on a Cursor ™ demonstration network. These entire tests apply to both phase 1 and phase 2 of the integration project. After successful integration of phase 3 all system tests shall be performed according the manufactures standard test process, CPS will assist only on request. As the cell reselection procedure will be changed completely it is strongly recommended that RR will be tested completely following the standard Texas Instruments test process (see paragraph 5.1).

4.2 Solution Proposals

As described earlier the E-OTD implementation as a first stage of location service is a cooperation between Texas Instruments and CPS as third party software. The Cursor ™ software as delivered by CPS is an additional module providing the measurement information processing. The scheduling of the measurements and the message handling with the network is done in the protocol stack where the processing of the location data is handled in the Cursor ™ software.

CPS recommends and supports the whole implementation in three phases:

1st – SMS based only in idle mode

2nd – SMS based even in dedicated mode

3rd – RRLP implementation for both modes

The advantage of the three phases is the testability of all changes in an early stage to prevent misbehaviour of the PS and the Layer 1 at a later stage. This leads on the other hand to a partly implementation of software (only MMI functionality) which might be redundant respectively not needed until a full MS-assisted E-OTD (MO-LR, MT-LR, NI-LR) implementation.

To realise RRLP as an own module and not as a new part of RR increases the testability and the customisation (not every customer might request LCS). New SAPs needs to be created, defining the communication between the entities. Keeping RR and RRLP separated also enables independent testing of the new functionality (RRLP and cell re-selection).

As described in paragraph 4.1 a solution with an additional layer (LC) between the actual Cursor ™ task and the interface towards RR and ACI is preferred.
All functional requirements listed in paragraph 4 are needed for a full E-OTD implementation supporting three types of Location Service operations:

- Mobile Originated Location Request (MO-LR),
- Mobile Terminated Location Request (MT-LR), and
- Network Induced Location Request (NI-LR)

All three types are supporting the new RRLP and the first two types additionally the call independent supplementary service needed for privacy verification, requesting own location position, location assistance data or broadcast assistance data message ciphering keys from the network. The NI-LR is intended for Emergency Service calls and completely independent of the supplementary service. There is also a special version of the MT-LR without HLR query, applicable to North America emergency calls only. The network signaling is somehow different to the normal MT-LR but identical for the MS to the NI-LR besides providing the NA-ESRK number additionally. A detailed message flow for these three different location requests can be found in Annex B. Out of these considerations arises two starting points for an implementation:

- Supporting limited E-OTD service only for emergency service calls with the NI-LR and MT-LR w/o HLR Query
- Supporting full E-OTD service with all three types of Location Service operations as listed above.

The first one is a subset of the full E-OTD service only reduced of the call independent supplementary service. As the full E-OTD service is not provided in all networks yet and is based on the limited E-OTD service extended with some features it is suggested to implement first the basic functionality and extend these in the following development. These considerations are independent of the implementation phases recommended by CPS and explained earlier in this paragraph. Besides that some MMI changes needed for the test phase are requested for a final E-OTD implementation (e.g. privacy verification).

The described solution covers only the idle/dedicated mode on the classical GSM control channels BCCH and CCCH but can also be extended for the new GPRS channels (PBCCH and PCCCH) as the measurements are done on the same channels as for CSD.

4.3 Block diagram of the software structure

First LCS implementation will be MS-assisted E-OTD. This is an overview of the software structure impact for a Location Service implementation. Figure 2 gives an overview of the involved respectively new entities. The highlighted entities are the ones directly acting as active parts by means of LCS. The other entities are 'only' involved indirectly as a transport media etc.

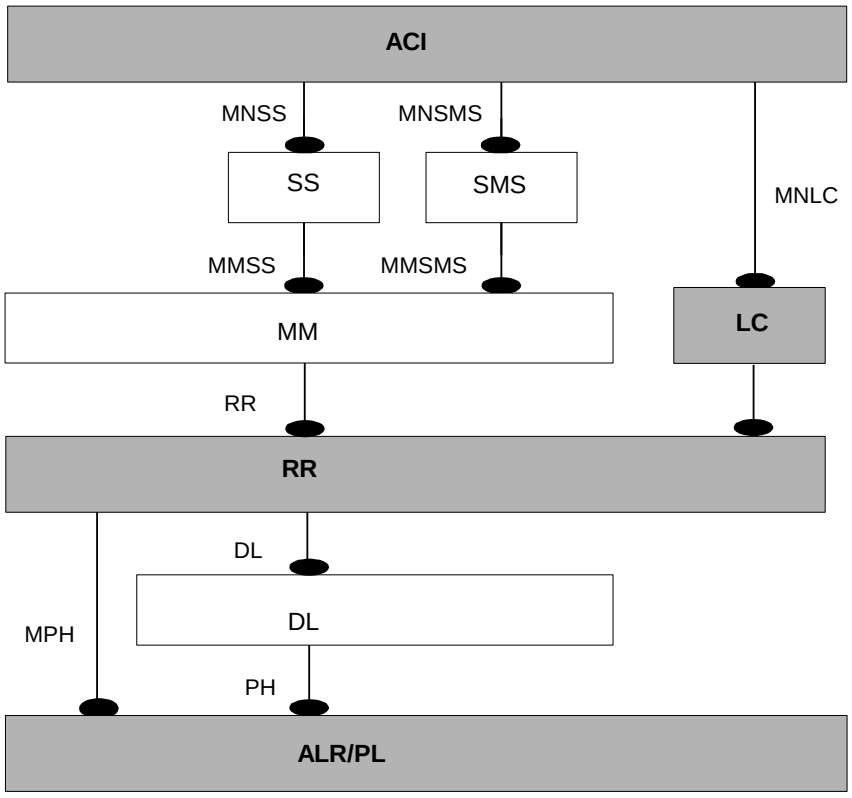


Figure 2: Block diagram of the software structure

The entity SS is only needed for a full E-OTD implementation where SS carries the privacy verification and the location request handling for MT-LR and MO-LR. ACI distributes the assistance data broadcast from the network (CBCH). The SMS entity is only needed for the test phase 1&2 as explained in chapter 4.2.

All positioning calculations and algorithms are based on the Cursor ™ module, provided by CPS. As the processing of the additional measurements are done inside the Cursor ™ task, the more detailed view of the Location Service looks as follows:

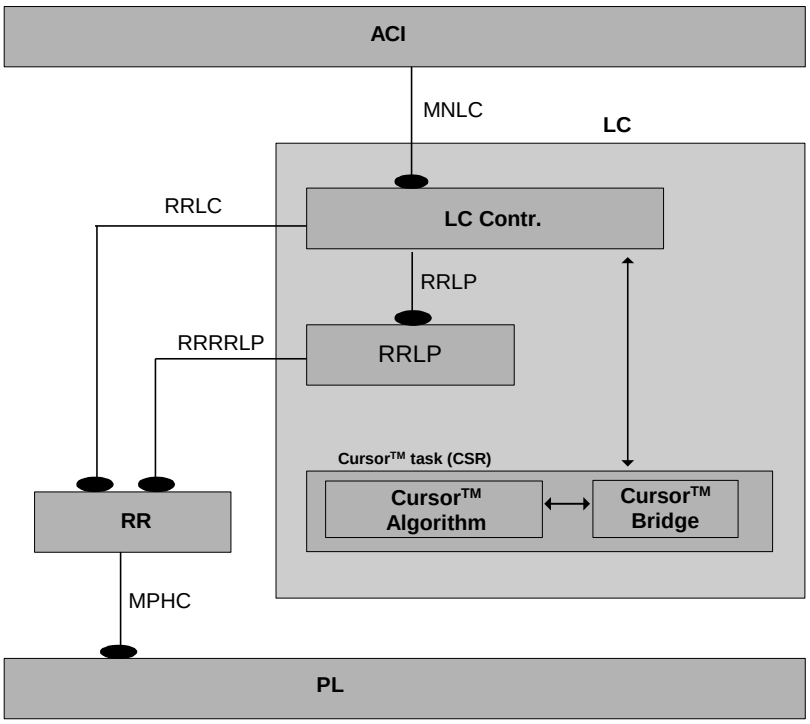


Figure 3: LC details

Figure 3 shows the details of the Cursor ™ task as provided by CPS. It consists of two parts, the Cursor ™ Algorithm and the Cursor ™ Bridge code. To have a more generic approach for further developments, the LC controller co-ordinates the positioning requests to the appropriate implementation, e.g. E-OTD or GPS. Texas Instruments will develop the LC controller and the RRLP. The Cursor ™ Bridge code is available in source code, representing the interface between the LC controller and the Cursor ™ Algorithm. It is used to exemplify the data handling between the modules but can be adapted to the Texas Instruments needs. The Cursor ™ Algorithm module is provided in object code, receiving the correlation data and BTS identifier and calculates precise OTD values. The Cursor ™ Algorithm remains property of CPS and will not be part of the Protocol Stack software release. The data handling is taking place inside RRLP or ACI (only during test phase 1 & 2 or for further implementations of assistance data). All point-to-point data, e.g. assistance data from the network and the location response from the MS, are handled by RRLP. General positioning data, e.g. assistance data to all mobiles in a cell, might be distributed via CBCH and is then transported via ACI to the LC. The interface between LC controller and RRLP is primitive based with functional character in order to run RRLP in another task context, e.g. RR.

4.4 Interface Identification

As a result of the previous contemplation the following interfaces are identified (separated for each signalling direction):

Originator	Addressee	Description of requirement	Reference
LC	RR	Start the acquisition of EOTD data for periodical and additional measurements.	
RR	LC	Supply LC with the result of the EOTD data acquisition.	[CU 0149]
ACI	LC	Transfer all additional identification information to the LC task; Position request during test phase 1 & 2.	
LC	ACI	Request location data and return processed information to the SMLC; Position response during test phase 1 &2.	[CU 0149]
LC controller	Cursor ™ task	Functional interface for transferring the raw E-OTD data acquired by RR.	
Cursor ™ task	LC controller	Functional interface for transferring the computed E-OTD data for further processing.	
Cursor ™ Bridge	Cursor ™ Algorithm	Functional interface inside the Cursor ™ task.	[CU 0107]
LC controller	RRLP	Functional interface transferring the computed E-OTD data to RRLP for the position measurement procedure as described in [3GPP 04.31].	
RRLP	LC controller	Functional interface transferring the decoded RRLP messages to the LC controller for further processing.	
RR	RRLP	Distributing all messages in relation with RRLP	[3GPP 03.71]
RRLP	RR	Handling of the complete position measurement procedure as described in [3GPP 04.31].	[3GPP 03.71]
RR	PL	Requesting periodic and extraordinary measurements for computing E-OTD data.	
PL	RR	Processing measurement data.	

Table 2: Interface identification for the LC module

4.5 Functional Requirements

The changes as explained in chapter 4.3 require 5 new SAPs for the communication with the neighbouring entities. The following listing explains the main task of each SAP:

- **RRLC SAP** – transport the measurement data from RR to the LC controller, handles the position requests.
- **RRRRLP** – handles the complete RRLP communication between the entities RR and RRLP.
- **RRLP SAP** – communication handling between LC controller and RRLP.
- **MNLC SAP** – handles the Measure Position Request/Response functionality for test phase 1&2 (SMS-based).

Implementing E-OTD completely as a first stage of LCS affects the following changes in the listed entities. The grey marked requirements are needed for the first stage of MS-assisted E-OTD (Emergency Call service) where the white marked requirements are part of the full MS-assisted E-OTD resp. MS-based E-OTD (CBCH) approach:

Requirement	Affected Entity	Description of requirement	Reference
LCS0100	**RR**	RRLC SAP	
LCS0101		RRRRLP SAP	
LCS0102		RR message catalogue	[3GPP 04.18]
LCS0103		Classmark(2&3) extension (Done in Rel 1.3.3)	[3GPP 24.008]
LCS0104		Transport E-OTD measurement request to Layer 1	
LCS0105		Transport E-OTD measurement results to RR	
LCS0106		Additional measurements on request (Measure Position Request)	[CU 0149]
LCS0107		Provide timing advance values at RRLC	[CU 0149]
LCS0108		Clock adjustments	[CU 0149]
LCS0200	**ALR**	Cell reselection adjustments	
LCS0201		Cell reselection-substitution	
LCS0300	**RRLP**	RR Location Service Protocol	[3GPP 04.31]
LCS0301		Message catalogue adjustments (ASN.1)	[X.209]
LCS0400	**SS**	LCS message send/receive	[3GPP_24.030]
LCS0401		Invoke start of location procedure (MO_LR, MT_LR)	[3GPP_24.080]
LCS0402		Handling of de-ciphering key	[3GPP_03.71]
LCS0500	**LC controller**	Positioning methods	
LCS0501		Data handling Cursor ™ task – RRLP – RR -	

		MNLC	
LCS0502		Control RRLP – Cursor™ task	
LCS0503		Controlling SS/SMS	
LCS0504		Interface LC – RRLP (New RRLP SAP (increase test ability))	
LCS0505		MNLC SAP	
LCS0600	**ACI/MMI**	CBCH Broadcast Assistance Data (MS-based E-OTD)	[3GPP 23.041]
LCS0601		Privacy verification	[3GPP_03.71]
LCS0602		Handling of location enabled numbers	[3GPP_03.71]
LCS0603		Send location data associated with a voice or data call	[3GPP_03.71]
LCS0604		Emergency call	[3GPP_03.71]
LCS0605		Support testing phase 1&2	[CU 0149]
LCS0700	**Cursor™ Bridge**	Cursor™ bridge integration	[CU 0107]
LCS0800	**PL**	MPH SAP adaptations	[TI S922]
LCS0900	**DL**	APDU Pre-emption	[3GPP_04.18]

Table 3: Requirement listing for the involved entities

In the following section are the requirements from Table 4 explained in more detail:

LCS0100 - RRLC SAP

Create a new RRLC SAP document and integrate it in the build environment. This SAP transfers all E-OTD measurements to LC.

PRIMITIVE	PARAMETERS	DIRECTION
RRLC_MEAS_REQ	ARFCN, BSIC, Expected OTD	LC -> RR
RRLC_MEAS_IND	Measurement data, TA	RR -> LC
RRLC_ERROR_IND	Cause ID	RR -> LC

Table 4: Primitive listing for RRLC SAP

- RRLC_MEAS_REQ, initiating a new measurement request due to a Measure Position Request from the NW.
- RRLC_MEAS_IND, transport the measurement results.
- RRLC_ERROR_IND, is used to indicate exceptional situations which do not allow the successful execution of
  the Position Measurement procedure.

LCS0101 - RRRRLP SAP

Create a new RRRRLP SAP document and integrate it in the build environment. This SAP transfers all E-OTD relevant APDUs to RRLP for further processing.

PRIMITIVE	PARAMETERS	DIRECTION
RRRRLP _DATA_IND	Measure Position Req or Assistance Data (both as APDU)	RR -> RRLP
RRRRLP _DATA_REQ	Measure Position Resp, Assistance Acknowledge (both as APDU) or the Protocol Error	RRLP -> RR
RRRRLP_ERROR_IND	Cause	RR -> RRLP

Table 5: Primitive listing for RRLC SAP

- RRRRLP_DATA_IND, this primitive is used to forward the Measure Position Request or the Assistance Data send by the Network (APDU).
- RRRRLP _DATA_REQ, this primitive is used to respond the Request or to acknowledge the Assistance Data (APDU).
- RRRRLP_ERROR_IND, this primitive is used to indicate an error while processing the RRLP message.

LCS0102 - RR message catalogue

Add the Application Information message to the RR message catalogue as defined in 3GPP 04.18. The segmentation and re-segmentation of the APDU needs to be done in RR prior sending the message to the NW or transferring the message to RRLP before decoding.

On receipt of an APDU containing an embedded 'RRLP Measure Position Request', RR will re-assembly the message if needed and forwards the information to RRLP using the RRRRLP_DATA_IND primitive, provided at the RRRRLP SAP.
On receipt of a response to the 'RRLP Measure Position Request' (RRRRLP_DATA_REQ) RR forwards the 'RRLP Measure Position response' containing the E-OTD or GPS measurements. The primitive is also used by the receiving entity (SMLC or MS) to indicate to the sending entity, that there is a problem that prevents the receiving entity to receive a complete and understandable component. The APDU for RRLP is explained in more detail in 3GPP 04.18.

Data receiving APDUs from SMLC to RRLP are:

- Measure Position Request
- Assistance Data

Data sending APDUs from RRLP to SMLC are:

- Measure Position Response
- Assistance Data Ackn
- Protocol Error

LCS0103 - Classmark(2&3) extension (Done in Rel 1.3.3)

Extend the classmark 2 and 3 structure inside the message catalogue with the additional LCS values - these changes are needed for the early classmark sending (3GPP 04.08).

- Classmark 2: LCS VA (Octet 5).
- Classmark 3: MS Positioning Method Capability & MS Positioning Method Capability

LCS0104 - Transport E-OTD measurement request to Layer 1

Passing the request from RR to Layer1. RR starts an E-OTD monitoring session by sending the primitive MPH_NCELL_POS_REQ to Layer1.

LCS0105 - Transport E-OTD measurement results to RR

Passing the measurement results from Layer1 to RR. Layer1 response to the MPH_NCELL_POS_REQ with a MPH_NCELL_POS_CNF for the serving cell and up to 12 neighbour cells (one message for each cell).

LCS0106 - Additional measurements on request (Measure Position Request)

On location request a new set of measurement data must be acquired – RR must trigger these measurements.

LCS0107 - Provide timing advance values at RRLC

Additionally TA values must be provided to the Cursor ™ algorithm

LCS0108 - Clock adjustments

No clock adjustments during neighbour cell measurements (Done in Layer1)

LCS0200 - Cell reselection adjustments

The Cursor ™ algorithm needs information for up to 12 neighbour cells and twice from the serving cell – first one prior to the neighbour cells and one set after the neighbour cell measurements. Adaptation of the code.

LCS0201 - Cell reselection - substitution

The Cursor ™ algorithm needs the neighbour cell information each 10 seconds to calculate precise positioning data. For operation without E-OTD the existing 30 seconds implementation is sufficient. To enable both approaches the existing PS software must be redesigned to these needs. A more detailed figure can be found in Annex A.

LCS0300 - RR Location Service Protocol

Design, implementation and test of the new RRLP protocol. This section only lists the Um Messages defined by 3GPP/ETSI for Location Services. For the detailed format and contents of these messages, see Annex A, ref [GSM 04.31] and [GSM 04.08] section 10.5.2.48.

Message Name	Reference
Measure Position Request	[GSM 04.31], 4.1
Measure Position Response	[GSM 04.31], 4.2
Assistance Data	[GSM 04.31], 4.3
Assistance Data Acknowledge	[GSM 04.31], 4.4
Protocol Error	[GSM 04.31], 4.5

Table 6: U_m messages for E-OTD

A new state machine with four states needs to be implemented.
STATES:

- IDLE - No LCS signalling transaction pending.
- ASSISTANCE DATA PENDING – receiving assistance data before a 'Measure Position Request'
- ASSISTANCE DATA COMPLETE – complete assistance data received
- DEDICATED – 'Measure Position Request' pending

LCS0301 - Message catalogue adjustments (ASN.1)

The RRLP message is coded completely in ASN.1 (3GPP 04.31). Adjust the coding and decoding algorithm respectively (basic ASN.1 functionality is already provided).

LCS0400 - LCS message send/receive

A location request (MO-LR/MT-LR) is initiated/handled via SS by sending/receiving a facility/register message (3GPP 03.71). SS controls the data handling outside the LC task.

LCS0401 - Invoke start of location procedure (MO_LR, MT_LR)

Invoke start of location procedure (MO_LR, MT_LR).
Mobile Originated Location Request (MO-LR)
LCS-MOLR (MS --> Network)
This operation type is invoked by an MS to request the network to start location procedure, which is used to provide the MS location estimate, location assistance data or deciphering keys for broadcast assistance data.
The MS shall invoke the MO-LR by sending a call independent SS Facility message to the network, of the form:
Facility(invoke=LCS-MOLR(molr-Type,locationMethod,lcs-QoS,lcsClientExternalID,mlc-Number,gpsAssistanceData))
The MS shall receive the result of the location request in a call independent SS FACILITY message of the form
Facility(Return result=LCS-MOLR(locationEstimate,decipheringKeys))

LCS-LocationNotification (network --> MS)
This operation type is invoked by the network to request a verification from the mobile subscriber for the attempted location request or to notify the subscriber about authorized location request.
The network shall invoke the MT-LR procedure by sending a call independent SS Facility message to the MS, of the form:
Facility(invoke=lcs-locationnotification(Type,locationType,lcsClientExternalID,lcsClientName))
The MS replies with a call independent SS RELEASE COMPLETE message containg the MS verification, of the form
Facility(Return result=LCS-LocationNotification(verificationResponse))

The target MS notifies the MS user of the location request and, if privacy verification was requested, the target MS indicates to the MS user whether the location request will be allowed or not allowed in the absence of a response and waits for the user to grant or withhold permission. The MS then returns a DTAP LCS Location Notification Return Result to the VMSC indicating, if privacy verification was requested, whether permission is granted or denied.

LCS0402 - Handling of de-ciphering key

Some of the data received via CBCH might be ciphered. SS handles the corresponding ciphering key. For privacy reason parts of the broadcast data may be ciphered.
The LCS Broadcast Data, when ciphered, will be partially ciphered according the LCS broadcast message definitions specified in GTS 04.35.

- The deciphering keys are needed in MS if the LCS Broadcast Data (ciphered parts) is ciphered
- If the operator indicates ciphering enabled or disabled RR has to take care of deciphering the broadcasted information
- The MS is capable to de-cipher the broadcast message (ciphered parts) using the cipher key (56 bits) delivered from NW to MS and using the Ciphering Serial Number (16 bits) included in the broadcast message.

- The deciphering keys' control system contains two keys (the Current Deciphering Key and the Next Deciphering Key) and the Ciphering Key Flag (indicating the current Ciphering Key Flag state in the location area in the time that the deciphering key set is delivered from SMLC to MS).
- Deciphering Key Set (Current and Next Deciphering Key, Ciphering Key Flag) are always location area specific. The MS starts to use the new set immediately. The Ciphering Key Flag controls the MS key usage (Current/Next Deciphering Key) as follows:
- After receiving the new deciphering key set, MS starts using the new set immediately.
- The Ciphering Key Flag in the LCS Broadcast Data message and the one received with MO-LR should have same polarity. This means that MS starts using the Current Deciphering Key immediately.
- When the Ciphering Key Flag state changes in the LCS Broadcast Data message then MS starts to use the Next Deciphering Key for deciphering the broadcast message. The Next Deciphering Key becomes now the Current Deciphering Key in MS.

LCS0500 - Positioning methods

There are two types of positioning methods applicable. Each of these is split again into two sub-methods (see below). Either one of these two major positioning methods is a mandatory requirement for a mobile Supporting Location services. In the first approach only MS assisted E-OTD is implemented but the design of the LC controller should also cover all other positioning methods:

- MS based E-OTD
- MS assisted E-OTD
- GPS based, and
- GPS assisted

LCS0501 - Data handling Cursor ™ task – RRLP – RR - MNLC

Create a new state machine for communication handling between RRLP and the Cursor ™ task

LCS0502 - Control RRLP – Cursor ™ task

Passing the RRLP data to the Cursor ™ task. Distribute the processed data (RRLP).

LCS0503 - Controlling SS/SMS

Passing the CBCH assistance data to the Cursor ™ task. Distribute the processed data (SMS-based for test purpose). The location data is sent to to the SMLC within a single SMS message. The data preparation is done in the Cursor ™ Bridge module.

LCS0504 - Interface LC – RRLP (New RRLP SAP (increase test ability))

Primitive based interface with functional character towards RRLP. Create a new RRLP SAP document and integrate it in the build environment.

PRIMITIVES	PARAMETERS	DIRECTION
RRLP_POS_IND	ARFCN, BSIC, Expected OTD, Location Method	RRLP -> LC

RRLP_POS_RES	Computed data, cause	LC -> RRLP

Table 7: Primitive listing for RRLP SAP

- RRLP_POS_IND, this primitive is used to pass the content of the Measure Position Request or the Assistant Data to the LC controller.
- RRLP_POS_RES, this primitive is used to send the computed data to RRLP for the RRLP (Measure Position Response) message.

LCS0505 - MNLC SAP

Three new primitives for the SAP communication are needed:

PRIMITIVES	PARAMETERS (Info elements of message)	DIRECTION
MNLC_SMS_MEAS_REQ	CsrSmsPosnDataReq	ACI -> LC
MNLC_SMS_MEAS_CNF	CsrSmsPosnDataCnf	LC -> ACI
MNLC_ACT_REQ		ACI -> LC

Table 8: Primitives and Parameters at MNLC-SAP - MS side

- MNLC_ SMS_MEAS_REQ - Receive a new Measure Position Request SMS message (only testphase 1 & 2).
- MNLC_ SMS_MEAS_CNF – Send a new Measure Position Response SMS message (only testphase 1 & 2).
- MNLC_MEAS_REQ – Trigger an action according the AT command specification [CU 0126].

The parameters are defined in [CU 0305].

LCS0600 - CBCH Broadcast Assistance Data (MS-based E-OTD)

Handling of the CBCH Broadcast Assistance Data. Pass the content of the CBCH message to LCS. The MS identifies the LCS SMSCB messages with E-OTD Message Identifier declared in [3GPP TS 23.41]. Four Types of LCS related SMSCB messages exist:

- LCS CBS Message Identifier for E-OTD Assistance Data message.
- LCS CBS Message Identifier for DGPS Correction Data message.
- LCS CBS Message Identifier for GPS Ephemeris and Clock Correction Data message.
- LCS CBS Message Identifier for GPS Almanac and Other Data message.

Broadcast Assistance data needs to be supported in MSs implementing MS-Based E-OTD, MS-Based GPS or MS Assisted GPS Location Services.

LCS0601 - Privacy verification

Check the settings of the privacy verification.

LCS0602 - Handling of location enabled numbers

Recognising of location enabled numbers and automatically sending the positioning data to the SMLC.

LCS0603 - Send location data associated with a voice or data call

Send location data associated with a voice or data call. The handling of the location data is dependent of the privacy verification (not in case of an emergency call).

LCS0604 - Emergency call

Passing the positioning data to the SMLC prior the actual call. In case of an emergency call the location data is send to the SMLC before the traffic channel is established.

LCS0605 - Support testing phase 1&2

Implementing test features (see chapter 4.2):

- 'Tag' selected numbers, or menu functions as location-enabled;
- Turn Cursor ™ functionality on/off using a global switch;
- Store and amend the SMLC addresses;
- Send location data to the SMLC in a single SMS message;
- Send the location data to the SMLC based upon the expiry of a timer, the duration of which shall be configurable;
- SMS-based MT-LR and MO-LR;

LCS0700 - Cursor ™ bridge integration

Adapt the reference design of the Cursor ™ Bridge to the Condat coding rules and integrate it into the frame. The bridge code is probably a state machine – further information will be provided by CPS.

LCS0800 - MPH SAP adaptations

Extend the MPH SAP with two primitives

PRIMITIVE	PARAMETERS	DIRECTION
MPH_NCELL_POS_REQ		RR -> ALR
MPH_NCELL_POS_IND	Measurement data for all cells	ALR -> RR

Table 9: Primitive listing for RRRRLP SAP

- MPH_NCELL_POS_REQ, this primitive is used to pass the measurement request to ALR.
- MPH_NCELL_POS_IND, this primitive is used to pass the periodic measurement data to RR.

LCS0900 - APDU Pre-emption

Add APDU pre-emption functionality according 3GPP 04.18.

5 Realisation

5.1 Testing

As described in 4.1 CPS will support testing phase 1 and phase 2, either at the manufactures side or at the CPS facilities, but will only assist for RRPL testing. The complete testing of first stage MS-assisted E-OTD implementation (E911) needs to be done in co-operation with a network operator (IOT).

The testcases described in 3GPP 51.010-1 no. 70 are not available yet. Entity Tests for the new entities (e.g. RRLP) have to be created, Entity Tests for existing entities (ACI, RR, ALR) have to be updated according to the LLD specification and the ETSI specs.
As the cell reselection algorithm is changed a complete FTA test for E-OTD enabled and normal PS is recommended.

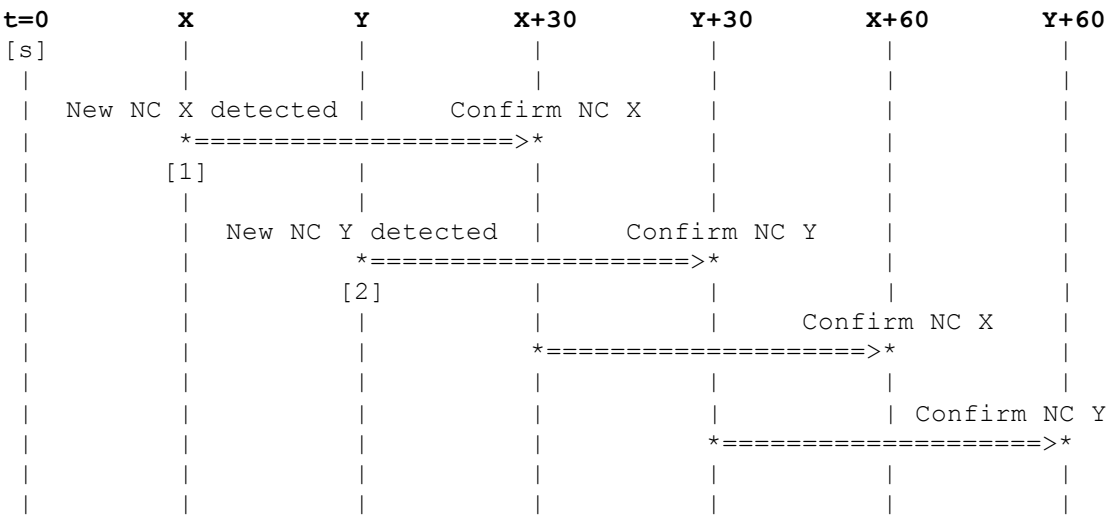
5.2 Open Points

These points are still open and need to be analysed:

6 Annex A

A.1. Existing Cell re-selection scheme

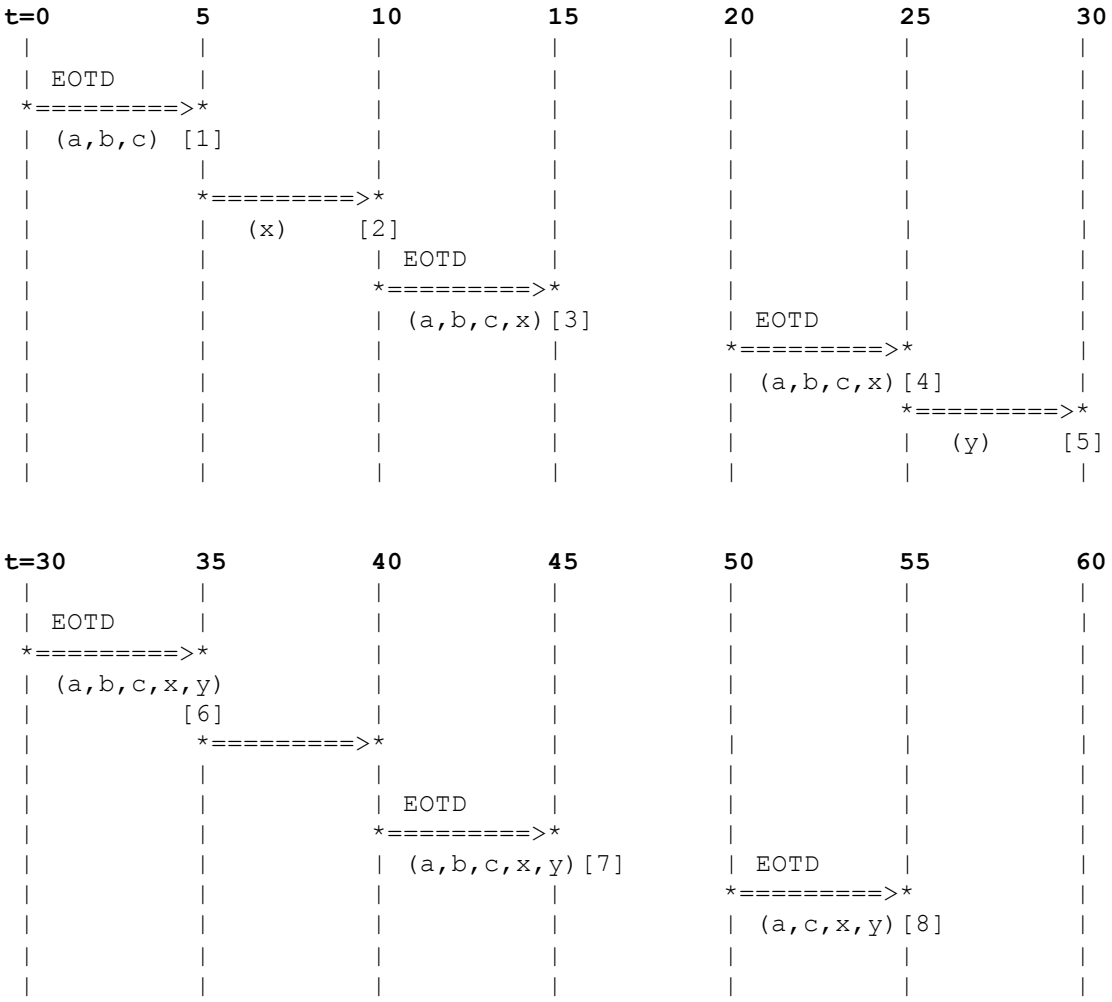
The sketched cell re-selection scheme below is implemented in RR of the protocol stack.



[1] Synchronize with new found NC X
[2] Synchronize with new found NC Y

The network supports the MS cell re-selection mechanism with a neighbour cell list spread with the system information periodically. Each time a new cell is part of this list the MS tries to synchronise (read FB and SB) with these cells and, if synchronisation succeeded, confirms them every 30 seconds. The confirmation is done individually for each neighbour cell once every 30 seconds.

A.2. New Cell re-selection scheme for E-OTD



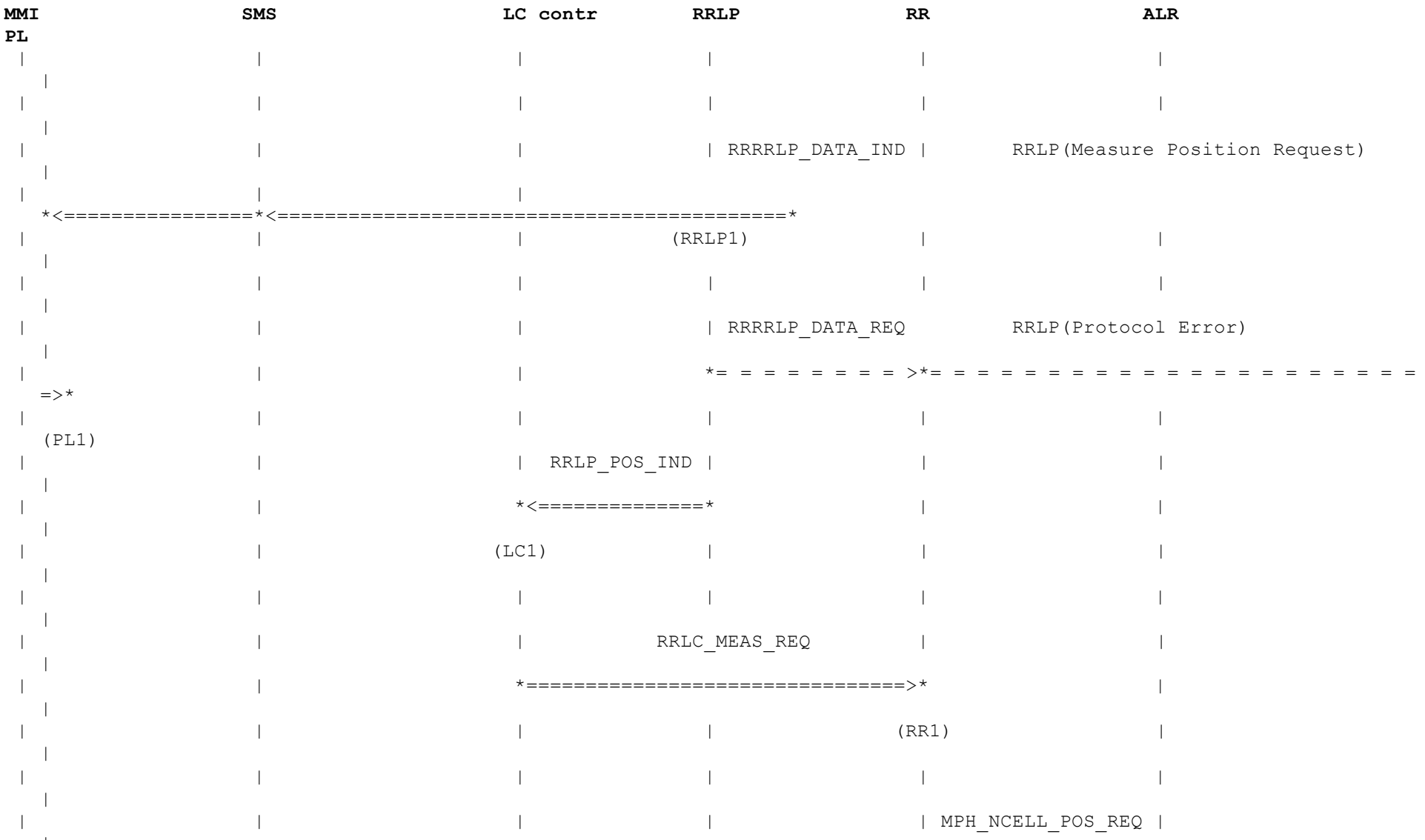
[1] Periodic EOTD measurements for NCs and SC (NC a,b,c)
[2] Synchronize with new found NC x
[3] Periodic EOTD measurements for NCs and SC (NC a,b,c,x)
[4] Periodic EOTD measurements for NCs and SC (NC a,b,c,x)
[5] Synchronize with new found NC y
[6] Periodic EOTD measurements for NCs and SC (NC a,b,c,x,y)
[7] Periodic EOTD measurements for NCs and SC (NC a,b,c,x,y)
[8] Periodic EOTD measurements for NCs and SC (NC a,c,x,y)

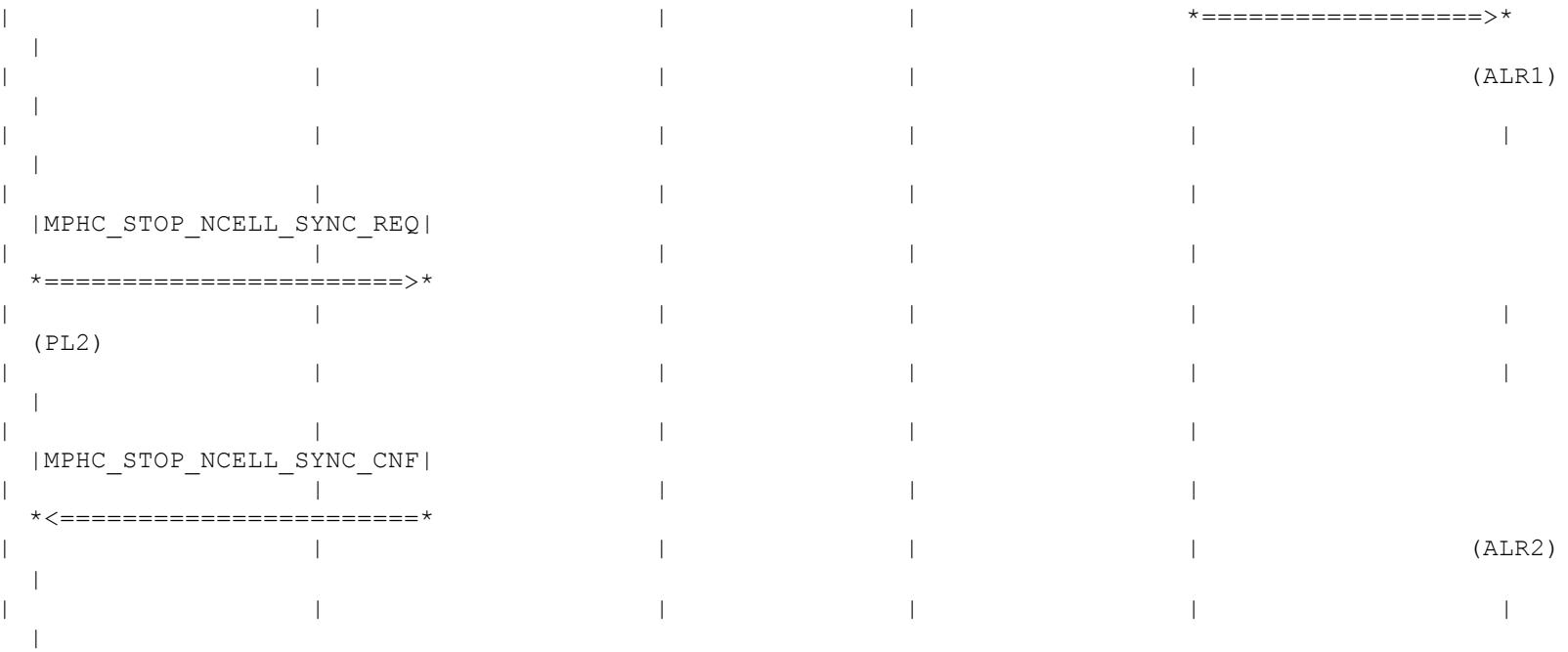
Again the network supports the MS cell re-selection mechanism with a neighbour cell list spread with the system information periodically. Each time a new cell is part of this list the MS tries to synchronise (read FB and SB) with these cells and, if synchronisation succeeded, confirms them every 30 seconds. The confirmation is done in common for all synchronised neighbour cells every 30 seconds. The E-OTD measurements are done periodically every 10 seconds as described before. This is the enhancement to the existing cell reselection solution.

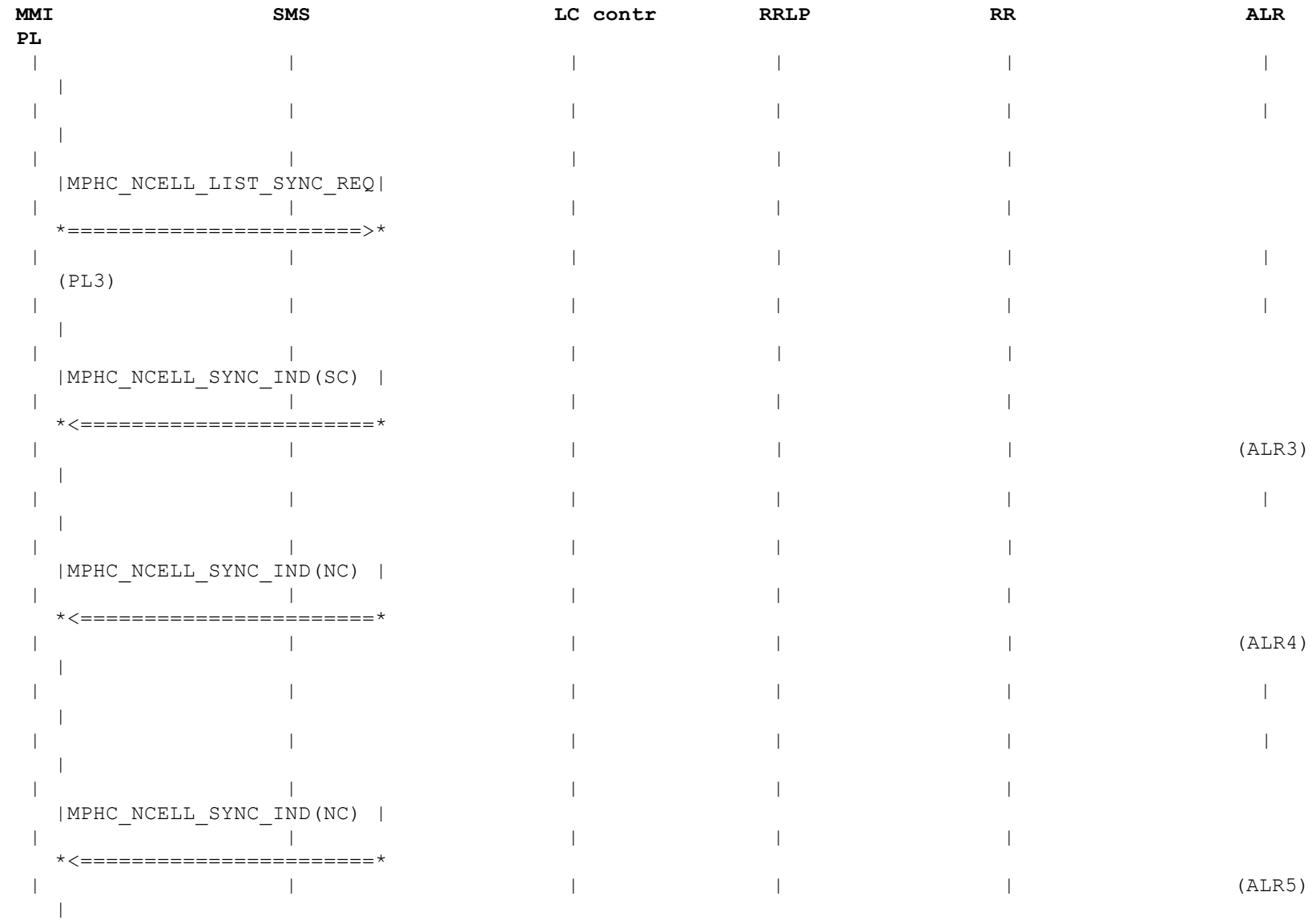
7 Annex B

The following MSCs are illustrating the message flow for the different operation types. They are qualifying a straightforward solution; no error cases are taken in account.

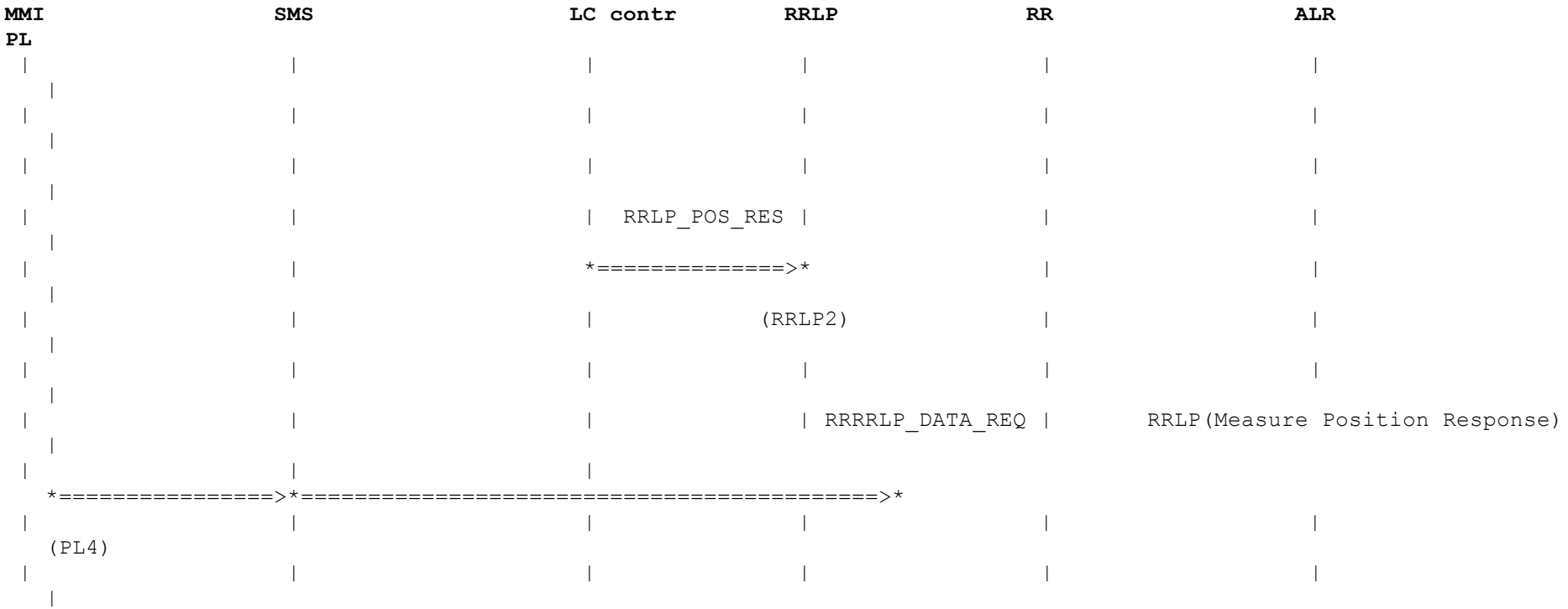
A.3. MSC RRLP




==========>
(ALR1)
|MPHC_STOP_NCELL_SYNC_REQ|
==========>
(PL2)
|MPHC_STOP_NCELL_SYNC_CNF|
<==========
(ALR2)


MMI
SMS
LC contr
RRLP
RR
ALR
PL
MPHC_NCELL_LIST_SYNC_REQ
(PL3)
MPHC_NCELL_SYNC_IND(SC)
(ALR3)
MPHC_NCELL_SYNC_IND(NC)
(ALR4)
MPHC_NCELL_SYNC_IND(NC)
(ALR5)


MPHC_NCELL_SYNC_IND(SC)
(ALR6)
MPH_NCELL_POS_CNF
(RR2)
RRLC_MEAS_CNF
(LC2)


MMI
SMS
LC contr
RRLP
RR
ALR
PL
RRLP_POS_RES
(RRLP2)
RRRRLP_DATA_REQ
RRLP(Measure Position Response)
(PL4)

(RRLP 1)
The network starts an RRLP-Measure Position Request. The component includes QoS, other instructions, and possible assistance data. The RRLP message contains a reference number of the request. The re-segmentation of the APDU takes part in the RR entity.

(PL 1)
The MS sends a RRLP message containing the Protocol Error component to the SMLC, if there is a problem that pretends the MS to receive a complete and understandable Measure Position Request component. The RRLP message contains the reference number included in the Measure Position Request received incomplete or erroneous.

(LC 1)
RRLP has checked the content of the message and pass the data to the LC controller who starts the data acquisition.

(RR 1)
The LC controller checks the location method and passes the additional request with the parameters provided by the Measure Position Request to RR. In case of a not supported location method an protocol error is generated (not covered in the MSC).

(ALR 1)
RR starts the measurement request by sending MPH_NCELL_POS_REQ to ALR. The data acquisition procedure starts with MPH_NCELL_POS_REQ and ends with the MPH_NCELL_POS_CNF.

(PL 2)
Before starting EOTD monitoring, ALR must stop neighbor cell monitoring process with a MPHC_STOP_NCELL_SYNC_REQ message for the active list.

(ALR 2)
Layer 1 confirms the NC monitoring process.

(PL 3)
ALR starts an EOTD monitoring session for the serving cell and up to 12 neighbor cells.

(ALR 3)
Layer1 sends the first monitoring results (serving cell) to ALR.

(ALR 4)
Layer1 sends the first monitoring results for the neighbor cells to ALR. Up to 12 neighbor cells are observed.

(ALR 5)
Layer1 sends the last monitoring results for the neighbor cells to ALR.

(ALR 6)
Layer1 sends again monitoring results for the serving cell to ALR.

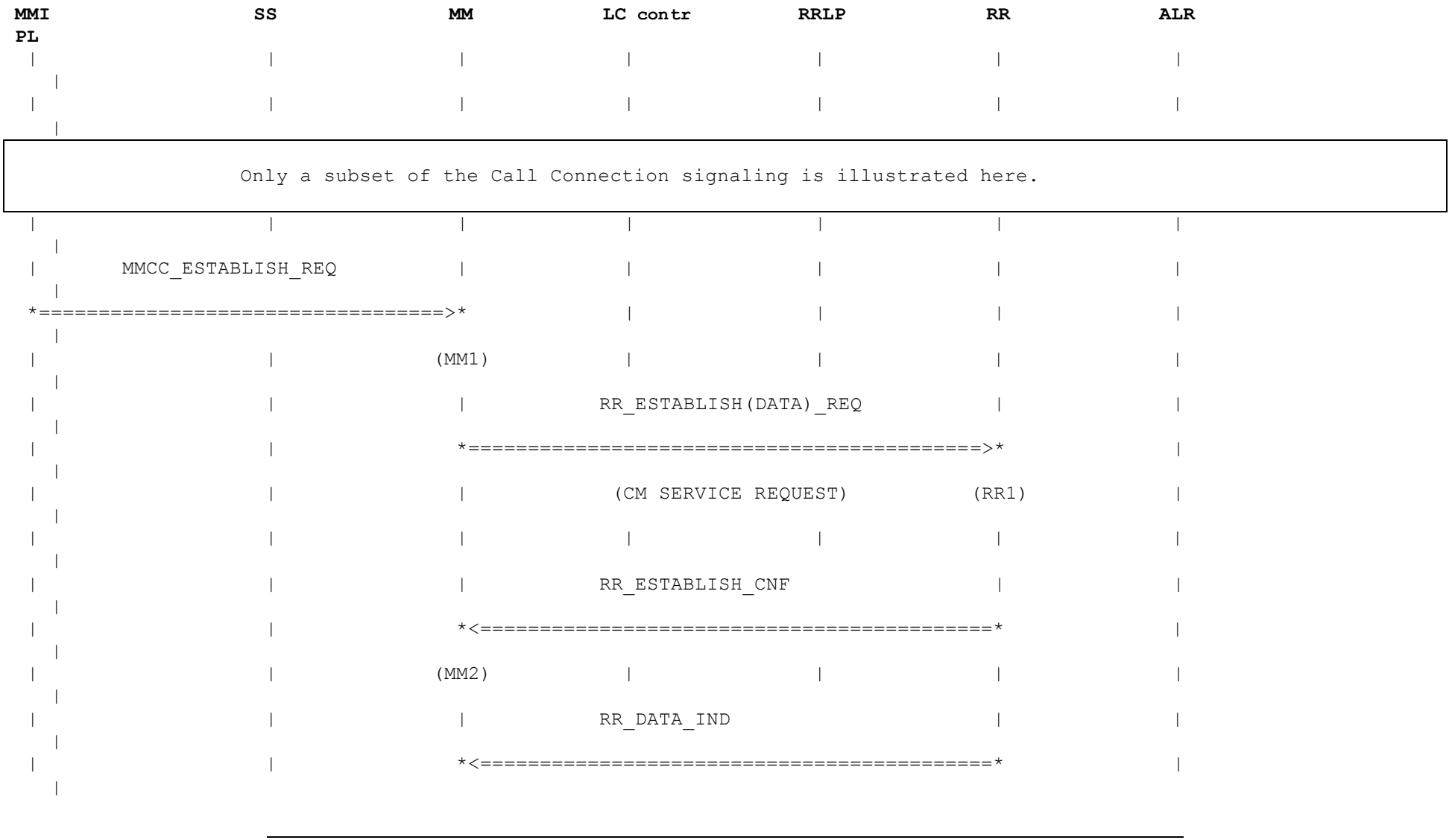
(RR 2)
The monitoring results for all observed cells are passed to RR.

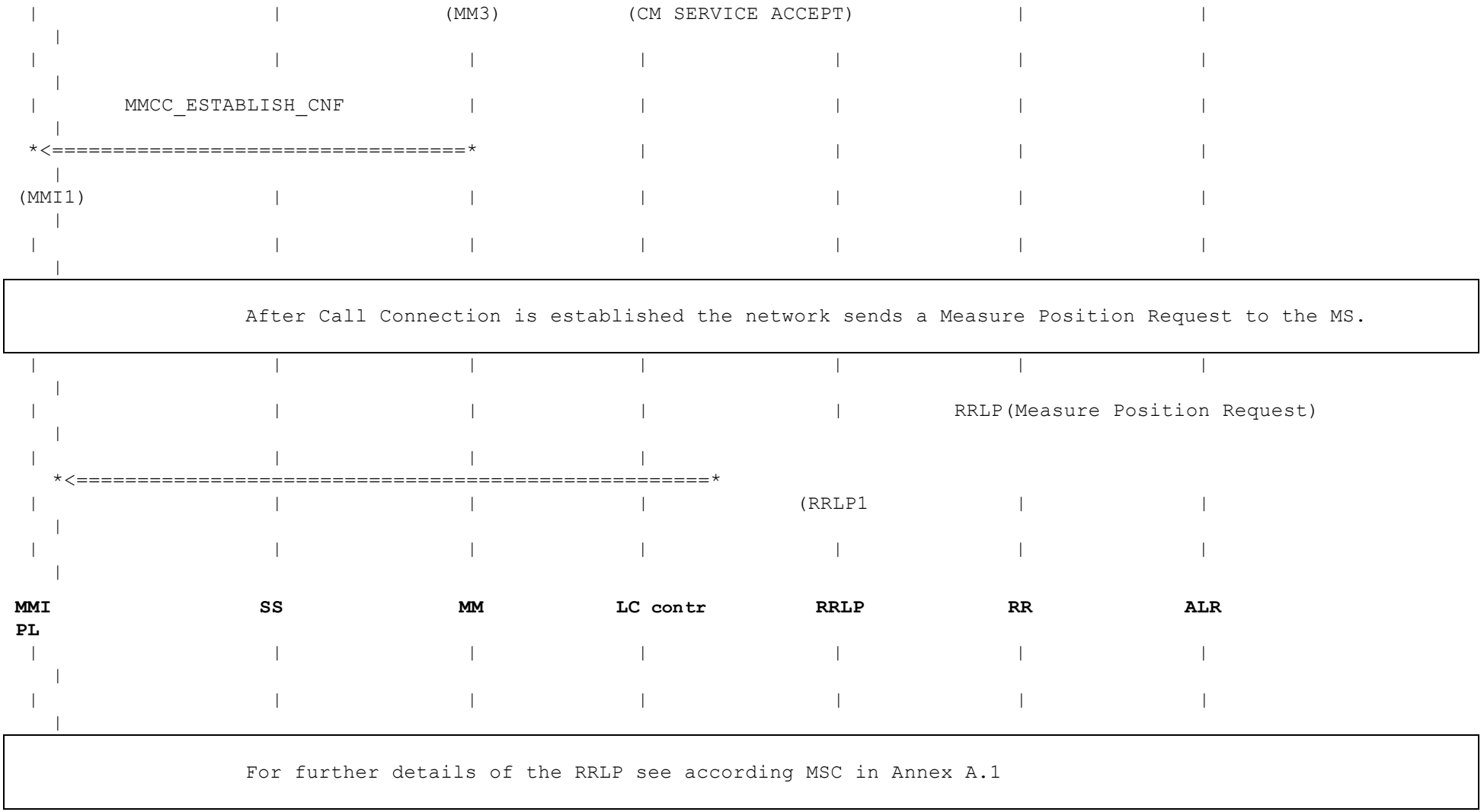
(LC 2)
RR passes the results to LC. The monitoring data is processed inside Cursor ™ and send back to LC for further handling.

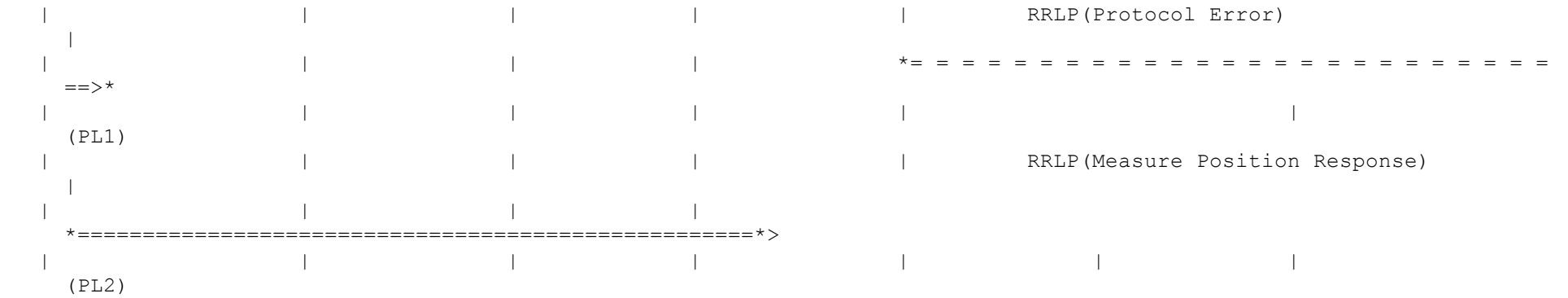
(RRLP 2)
The Cursor ™ module processes all monitored data. The result is passed to RRLP for further processing – encoding.

(PL 4) The processed data is passed to RR for APDU segmentation. RRLP sends a Measure Position Response message to the Network.

A.4. MSC NI-LR


MMI
PL
SS
MM
LC contr
RRLP
RR
ALR
Only a subset of the Call Connection signaling is illustrated here.
MMCC_ESTABLISH_REQ
(MM1)
RR_ESTABLISH(DATA)_REQ
(CM SERVICE REQUEST)
(RR1)
RR_ESTABLISH_CNF
(MM2)
RR_DATA_IND


(MM3)
(CM SERVICE ACCEPT)
MMCC_ESTABLISH_CNF
(MMI1)
After Call Connection is established the network sends a Measure Position Request to the MS.
RRLP(Measure Position Request)
(RRLP1
MMI
SS
MM
LC contr
RRLP
RR
ALR
PL
For further details of the RRLP see according MSC in Annex A.1


RRLP(Protocol Error)
RRLP(Measure Position Response)
(PL1)
(PL2)

(MM 1)
A CC connection is requested with a MMCC ESTABLISH REQ primitive. The used transaction identifier is in the range 0 to 6.

(RR 1)
Depending on whether already a RR connection exists, MM uses the RR ESTABLISH REQ or RR DATA REQ primitive to forward the initial CM Service Request message describing the requested service from the upper layer.

(MM 2)
The RR connection is established. MM starts T3240 and waits for the response of the network. Details aren't illustrated.

(MM 3)
If the infrastructure is able to process the requested service, it sends a CM Service Accept message to MM.

(MMI1)
The MM connection is established.

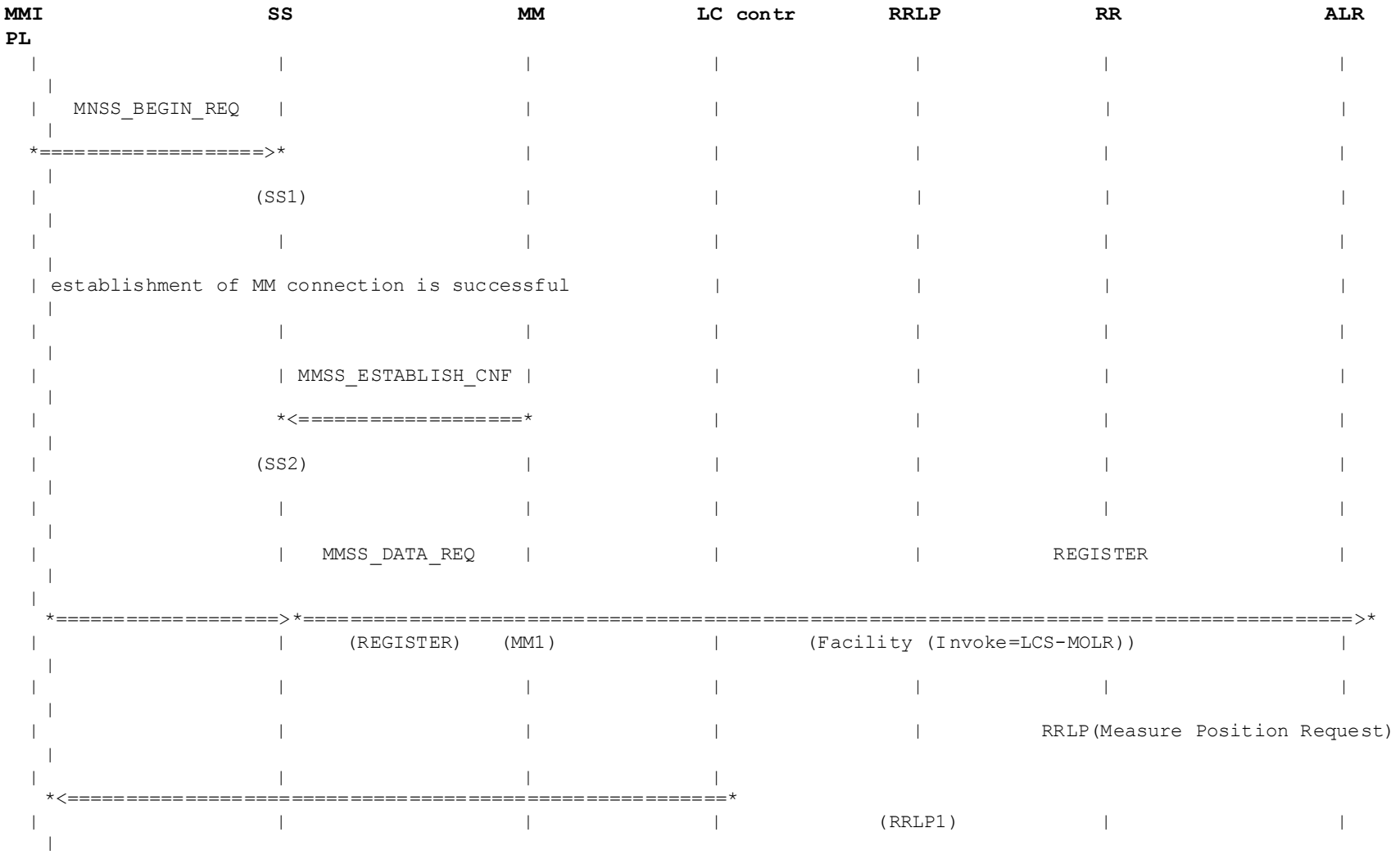
(RRLP 1)
The network starts an RRLP-Measure Position Request. The component includes QoS, other instructions, and possible assistance data. The RRLP message contains a reference number of the request. The RRLP illustration in this MSC is simplified, no dependencies on the kind of location request exist. For a detailed overview see MSC RRLP.

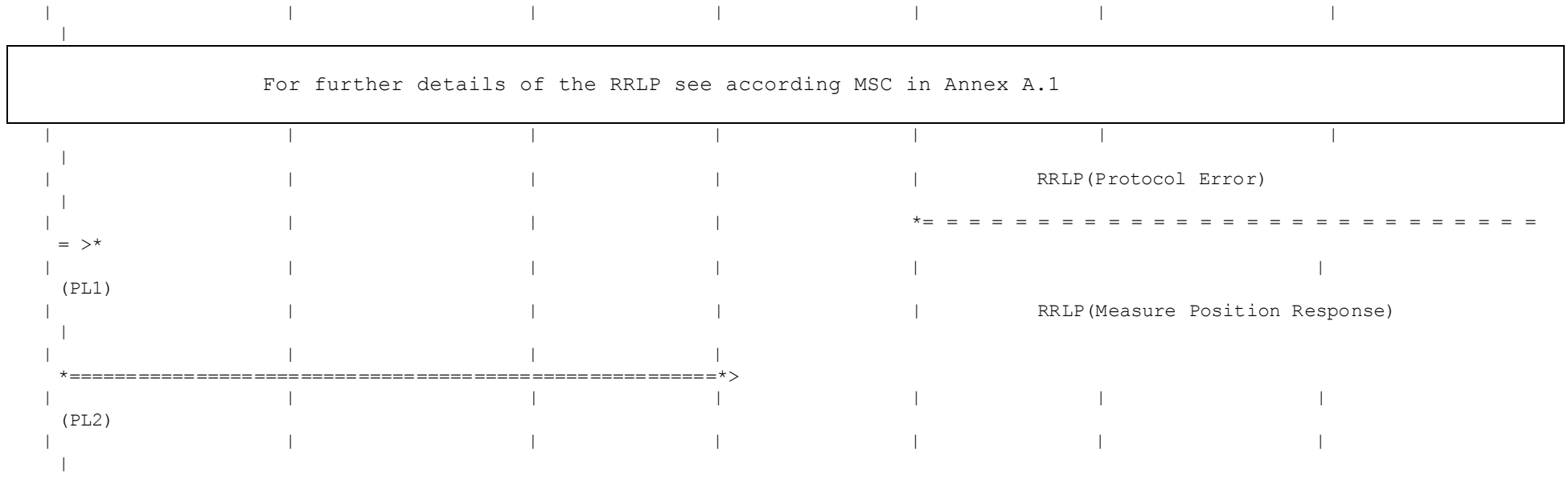
(PL 1)
The MS sends a RRLP message containing the Protocol Error component to the SMLC, if there is a problem that pretends the MS to receive a complete and understandable Measure Position Request component. The RRLP message contains the reference number included in the Measure Position Request received incomplete.

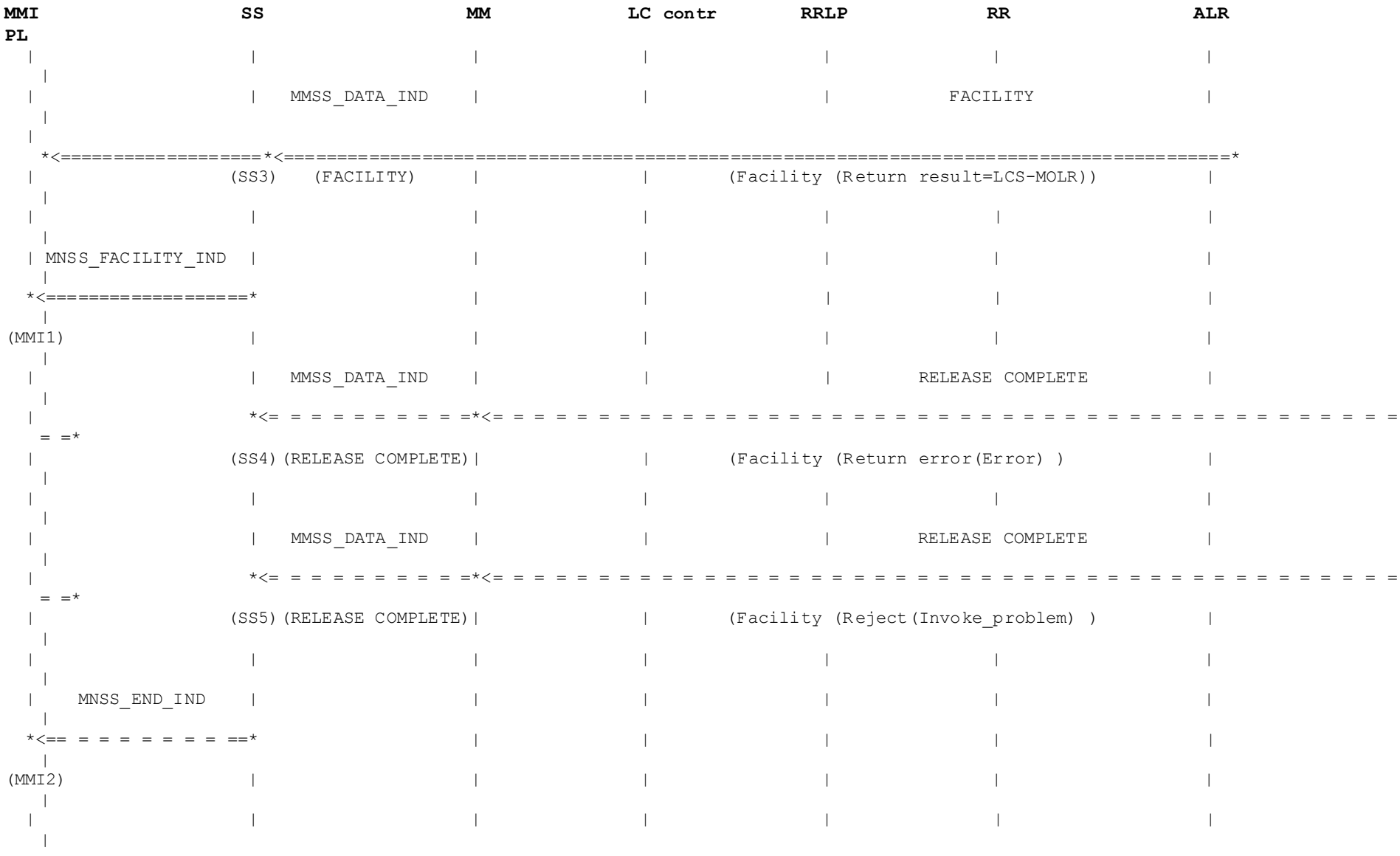
(PL 2)
RR sends the RRLP-Measure Position Response message to the network.

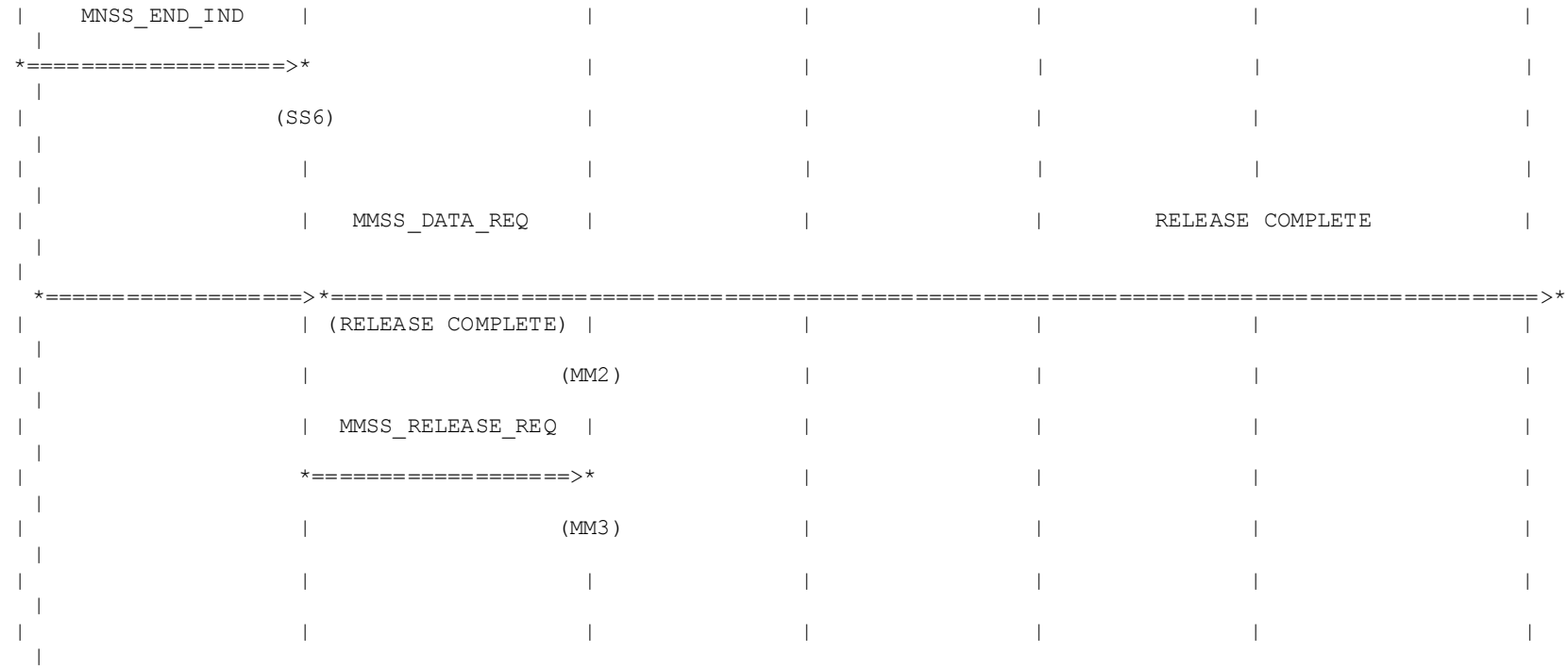
A.5. MSC MO-LR

Single mobile originated location request




For further details of the RRLP see according MSC in Annex A.1
RRLP(Protocol Error)
(PL1)
RRLP(Measure Position Response)
(PL2)


MMI
SS
MM
LC contr
RRLP
RR
ALR
PL
MMSS_DATA_IND
FACILITY
(SS3) (FACILITY)
(Facility (Return result=LCS-MOLR))
MNSS_FACILITY_IND
(MMI1)
MMSS_DATA_IND
RELEASE COMPLETE
(SS4)(RELEASE COMPLETE)
(Facility (Return error(Error))
MMSS_DATA_IND
RELEASE COMPLETE
(SS5)(RELEASE COMPLETE)
(Facility (Reject(Invoke_problem))
MNSS_END_IND
(MMI2)


MNSS_END_IND
(SS6)
MMSS_DATA_REQ
RELEASE COMPLETE
(RELEASE COMPLETE)
(MM2)
MMSS_RELEASE_REQ
(MM3)

(SS 1)
MMI starts establishment of a connection. A facility information element and the SS version info are forwarded to SS. SS checks the transaction identifier. It is not expected that this leads to a problem, because the MS shall make no internal errors. If this check fails, the request is ignored.

(SS 2)
MM has established a MM connection successfully and confirms this to SS.

(MM 1)
The MS invokes a MO-LR by sending a REGISTER message to the network containing a LCS-MOLR invoke component. SS version Indicator value 1 or above shall be used.

(RRLP 1)
The network starts a RRLP-Measure Position Request. The component includes QoS, other instructions, and possible assistance data. The RRLP message contains a reference number of the request. The RRLP illustration in this MSC is simplified, no dependencies on the kind of location request exist. For a detailed overview see MSC RRLP.

(PL 1)
The MS sends a RRLP message containing the Protocol Error component to the SMLC, if there is a problem that pretends the MS to receive a complete and understandable Measure Position Request component. The RRLP message contains the reference number included in the Measure Position Request received incomplete.

(PL 2)
RR sends the RRLP-Measure Position Response message to the network.

(SS 3)
The network shall pass the result of the location procedure to the MS by sending a FACILITY message to the MS containing a LCS-MOLR return result component. The network shall pass the result of the location procedure to the MS only if the location estimate is given in a format that the MS supports.

(MMI 1)
SS decodes the message and forwards the facility information element to MMI.

(SS 4)
MMI sends a facility information to the infrastructure without releasing the connection.

(SS 5)
If one of the components received from the MS is incorrect, the network returns a reject indication by sending a RELEASE COMPLETE message containing a reject component.

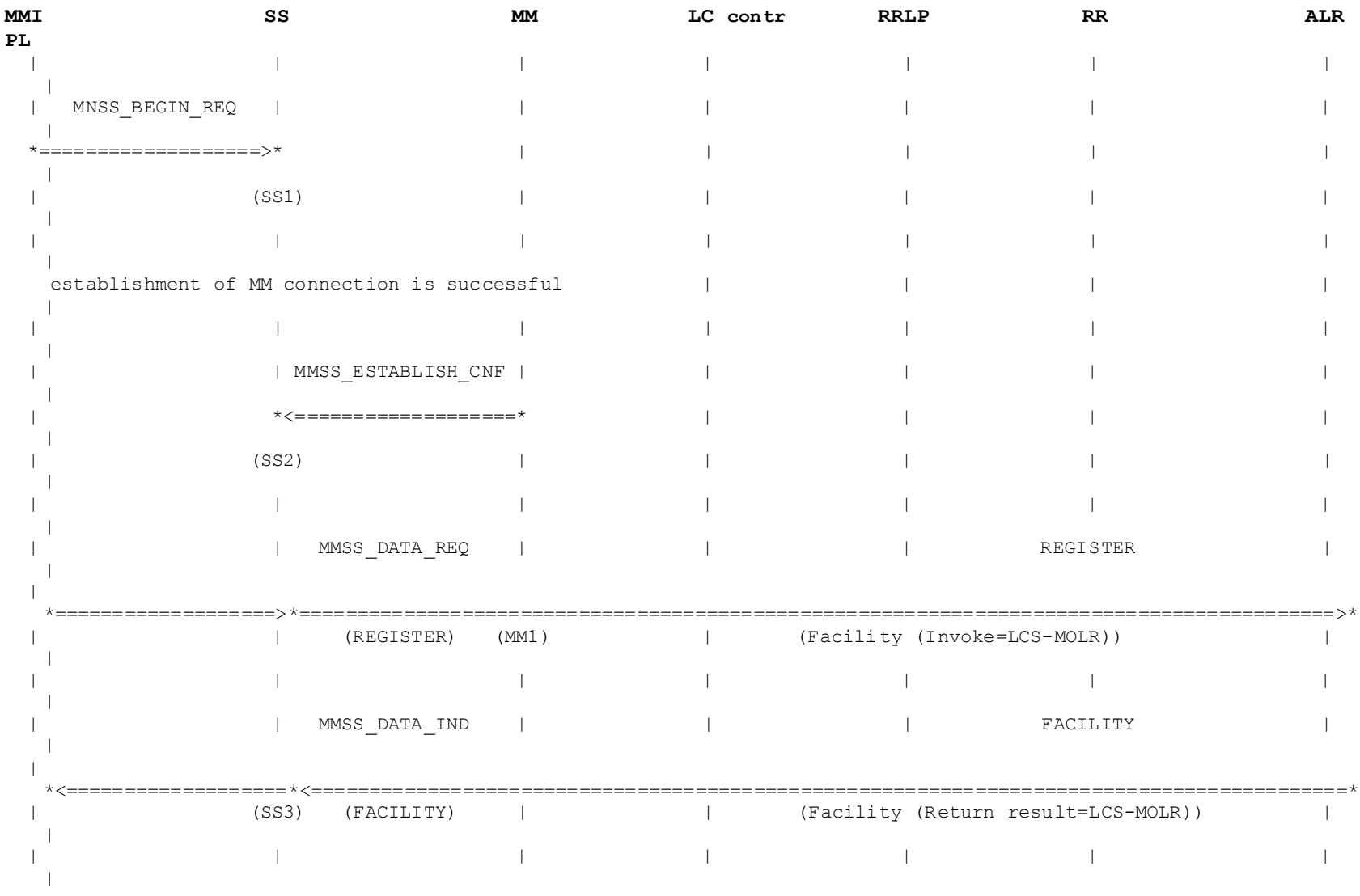
(MMI 2)
SS decodes the message and forwards the content to MMI.

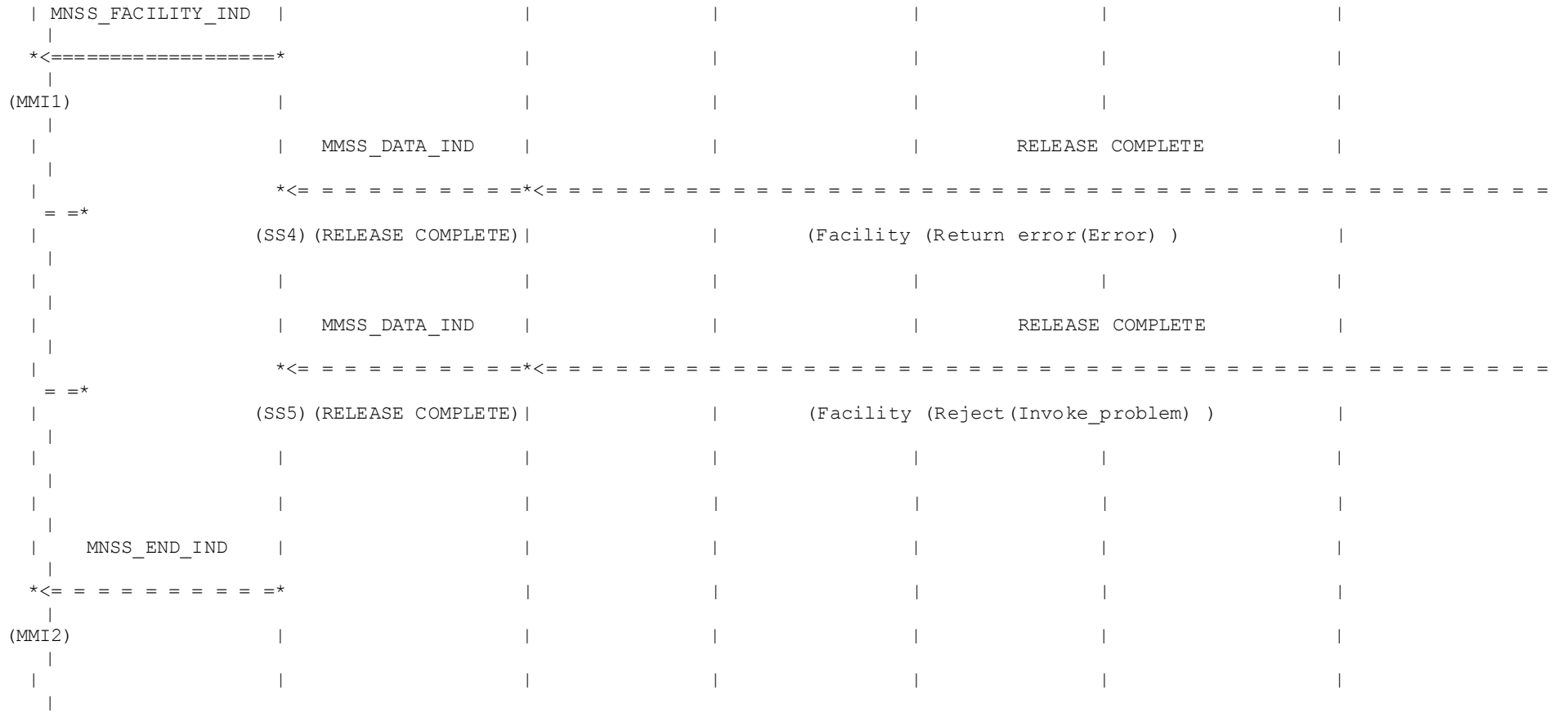
(SS 6)
MMI will release the transaction. The last message of a SS transaction is the SS RELEASE COMPLETE message.

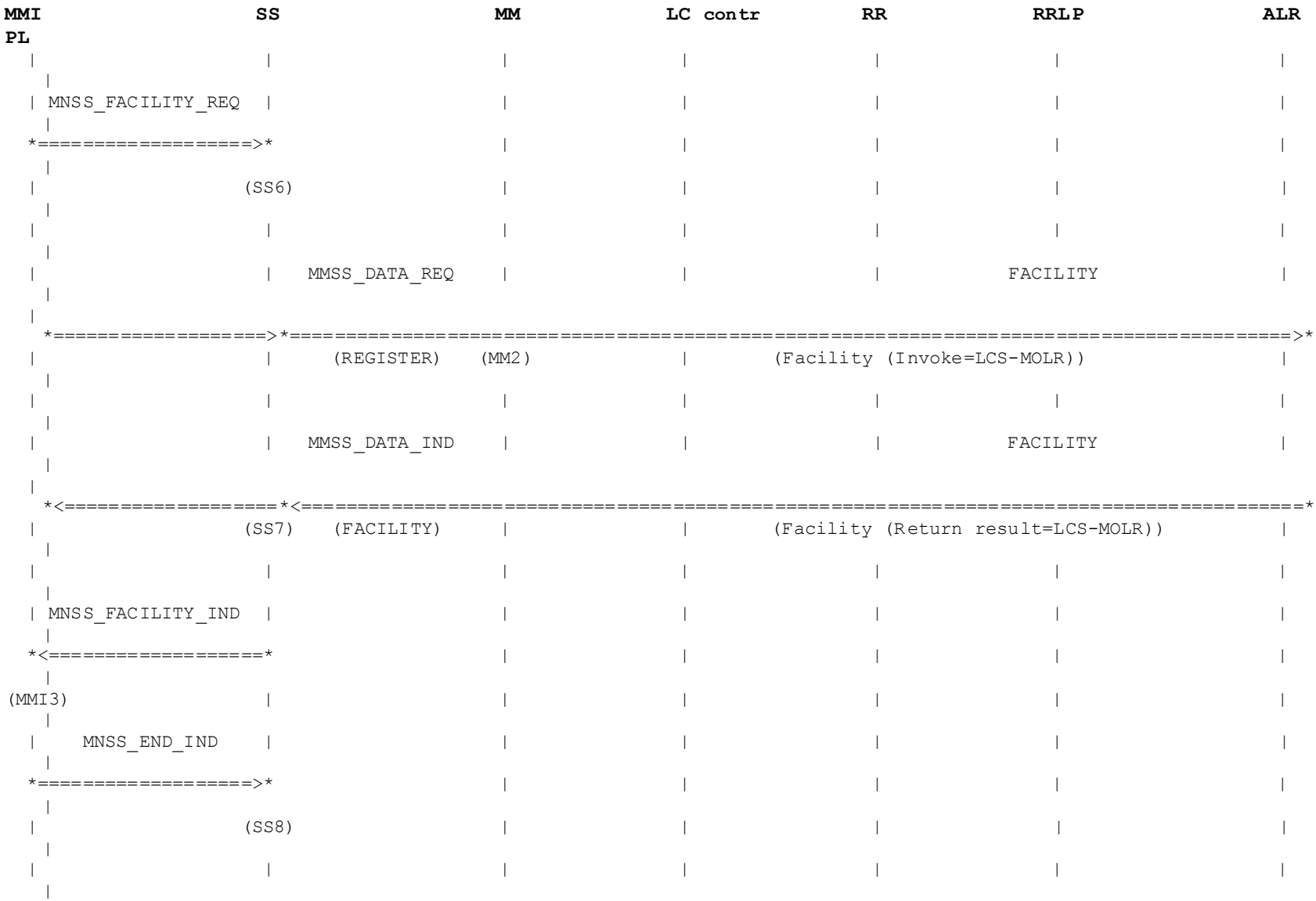
(MM 2)
The MS terminate the dialogue by sending a RELEASE COMPLETE message.

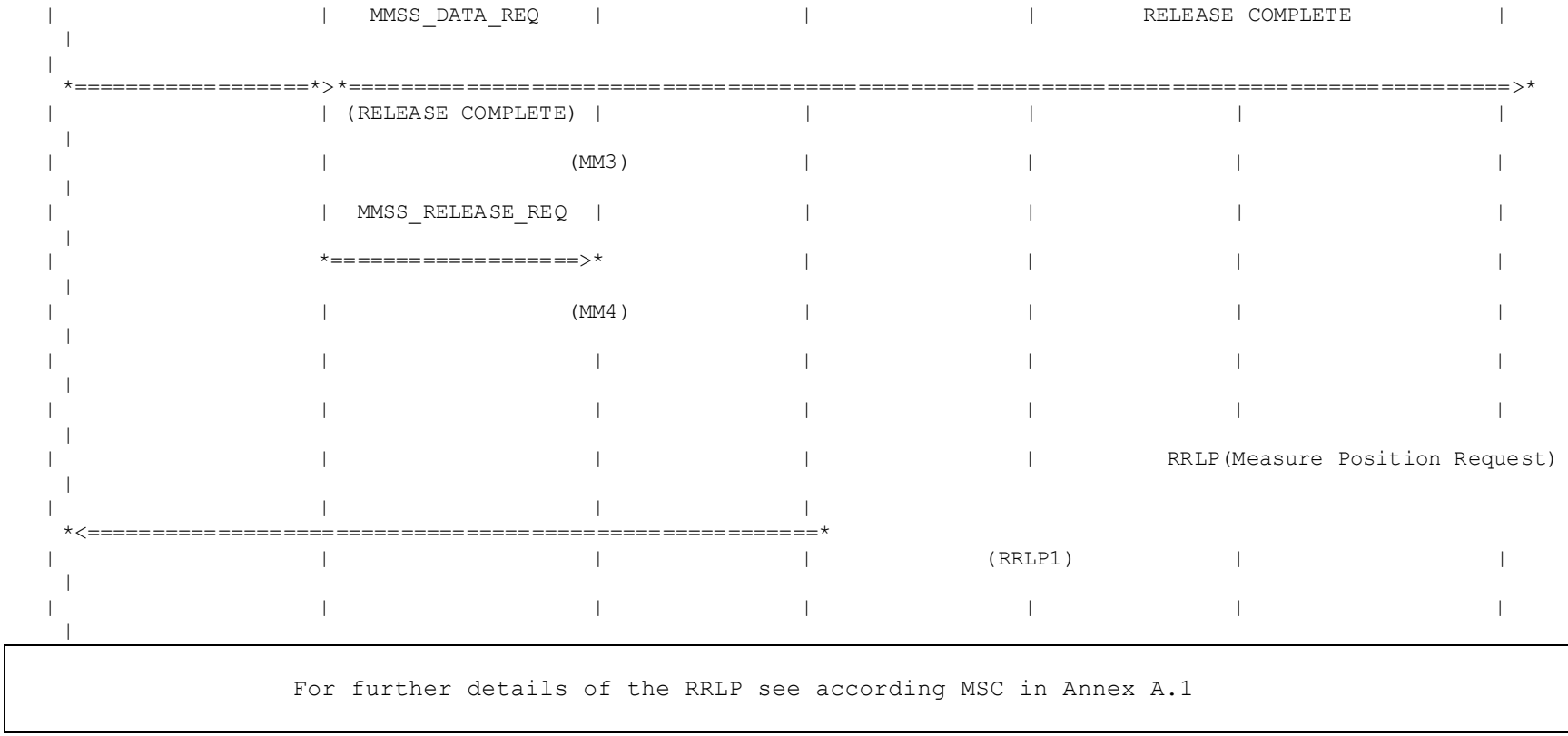
(MM 3)
MM is informed about the end of transaction.

Multiple mobile originated location requests

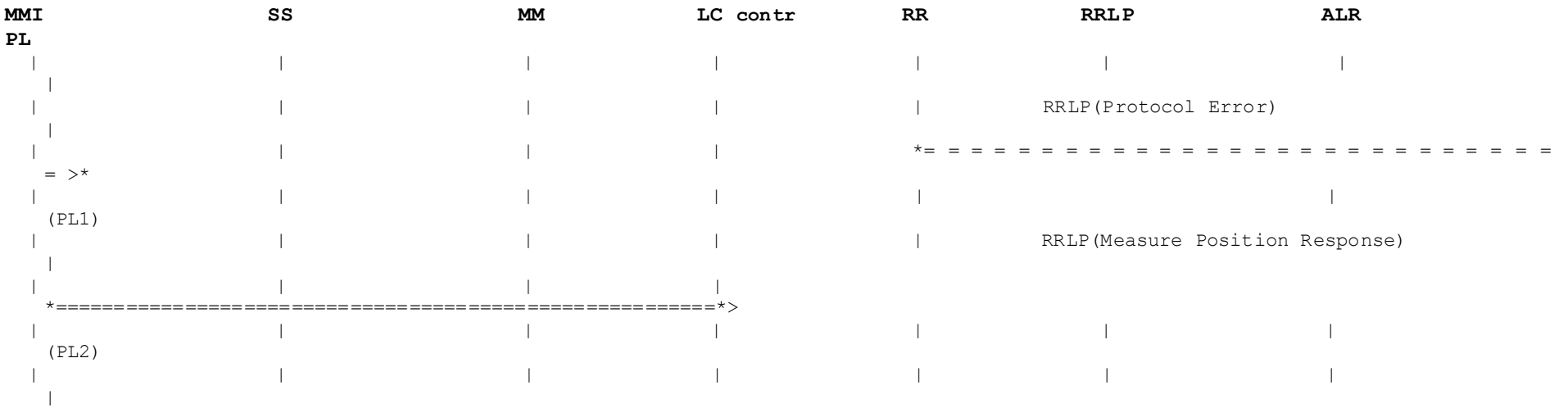



MNSS_FACILITY_IND
(MMI1)
MMSS_DATA_IND
RELEASE COMPLETE
(SS4)(RELEASE COMPLETE)
(Facility (Return error(Error))
MMSS_DATA_IND
RELEASE COMPLETE
(SS5)(RELEASE COMPLETE)
(Facility (Reject(Invoke_problem))
MNSS_END_IND
(MMI2)


MMI
SS
MM
LC contr
RR
RRLP
ALR
PL
MNSS_FACILITY_REQ
(SS6)
MMSS_DATA_REQ
FACILITY
(REGISTER)
(MM2)
(Facility (Invoke=LCS-MOLR))
MMSS_DATA_IND
FACILITY
(SS7)
(FACILITY)
(Facility (Return result=LCS-MOLR))
MNSS_FACILITY_IND
(MMI3)
MNSS_END_IND
(SS8)



For further details of the RRLP see according MSC in Annex A.1


MMI
SS
MM
LC contr
RR
RRLP
ALR
PL
RRLP(Protocol Error)
(PL1)
RRLP(Measure Position Response)
(PL2)

(SS 1)
MMI starts establishment of a connection. A facility information element and the SS version info are forwarded to SS. SS checks the transaction identifier. It is not expected that this lead to a problem, because the MS shall make no internal errors. If this check fails, the request is ignored.

(SS 2)
MM has established a MM connection successfully and confirms this to SS.

(MM 1)
The MS invokes a MO-LR by sending a REGISTER message to the network containing a LCS-MOLR invoke component. SS version Indicator value 1 or above shall be used.

(SS 3)
The network shall pass the result of the location procedure to the MS by sending a FACILITY message to the MS containing a LCS-MOLR return result component. The network shall pass the result of the location procedure to the MS only if the location estimate is given in a format that the MS supports.

(MMI 1)
SS decodes the message and forwards the facility information element to MMI.

(SS 4)
MMI sends a facility information to the infrastructure without releasing the connection.

(SS 5)
If one of the components received from the MS is incorrect, the network returns a reject indication by sending a RELEASE COMPLETE message containing a reject component.

(MMI 2)
SS decodes the message and forwards the content to MMI.

(SS 6)
MMI sends a facility information to the infrastructure without releasing the connection.

(MM 2)
The MS initiate another location request operation by sending a FACILITY message to the network containing a LCS-MOLR invoke component. After the last location request operation the MS shall terminate the dialogue by sending a RELEASE COMPLETE message.

(SS 7)
The network shall pass the result of the location procedure to the MS by sending a FACILITY message to the MS containing a LCS-MOLR return result component. The network shall pass the result of the location procedure to the MS only if the location estimate is given in a format that the MS supports.

(MMI 3)
SS decodes the message and forwards the content to MMI.

(SS 8)
MMI will release the transaction. The last message of a SS transaction is the SS RELEASE COMPLETE message.

(MM 3)
The MS terminate the dialogue by sending a RELEASE COMPLETE message.

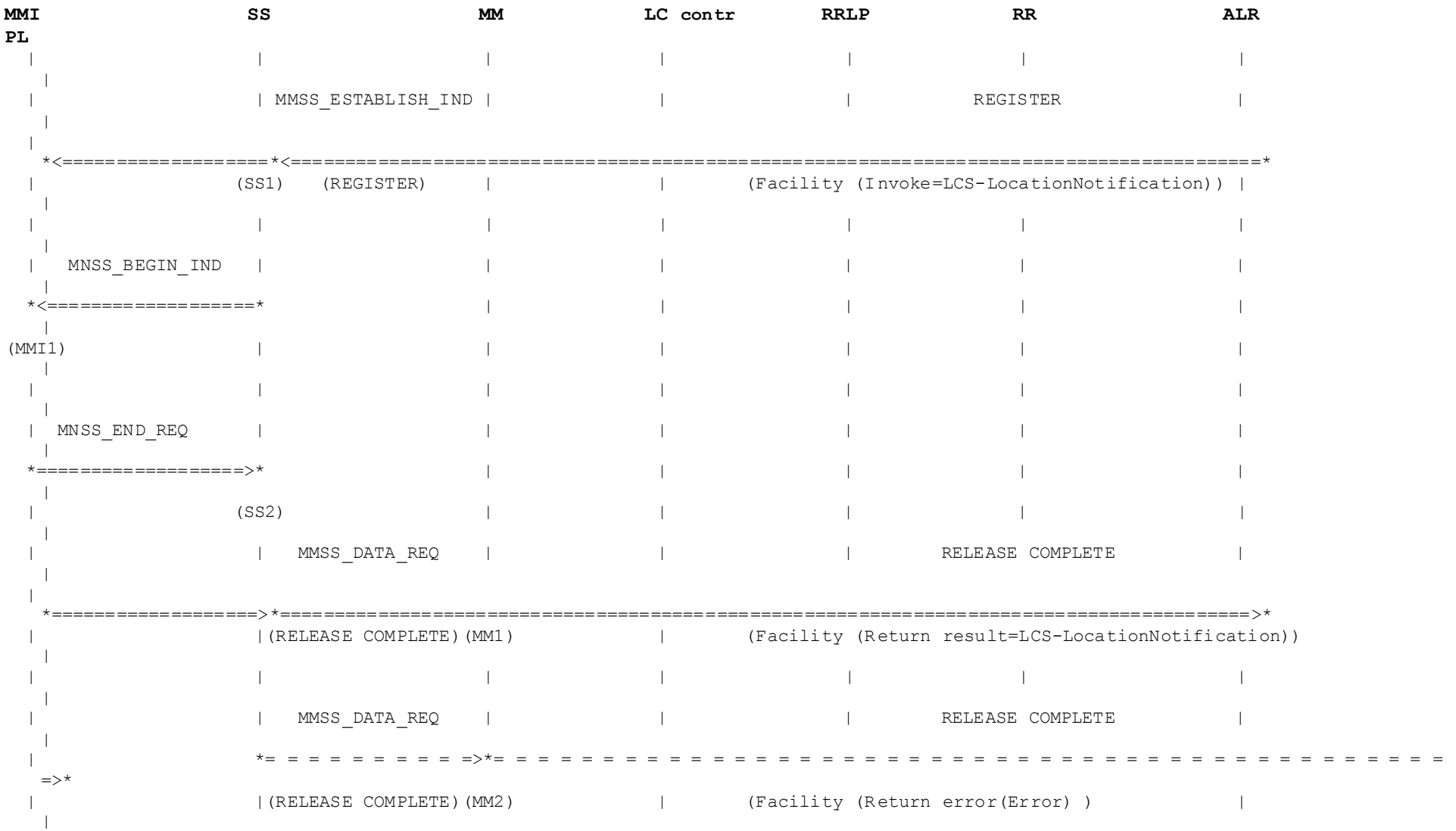
(MM 4)
MM is informed about the end of transaction.

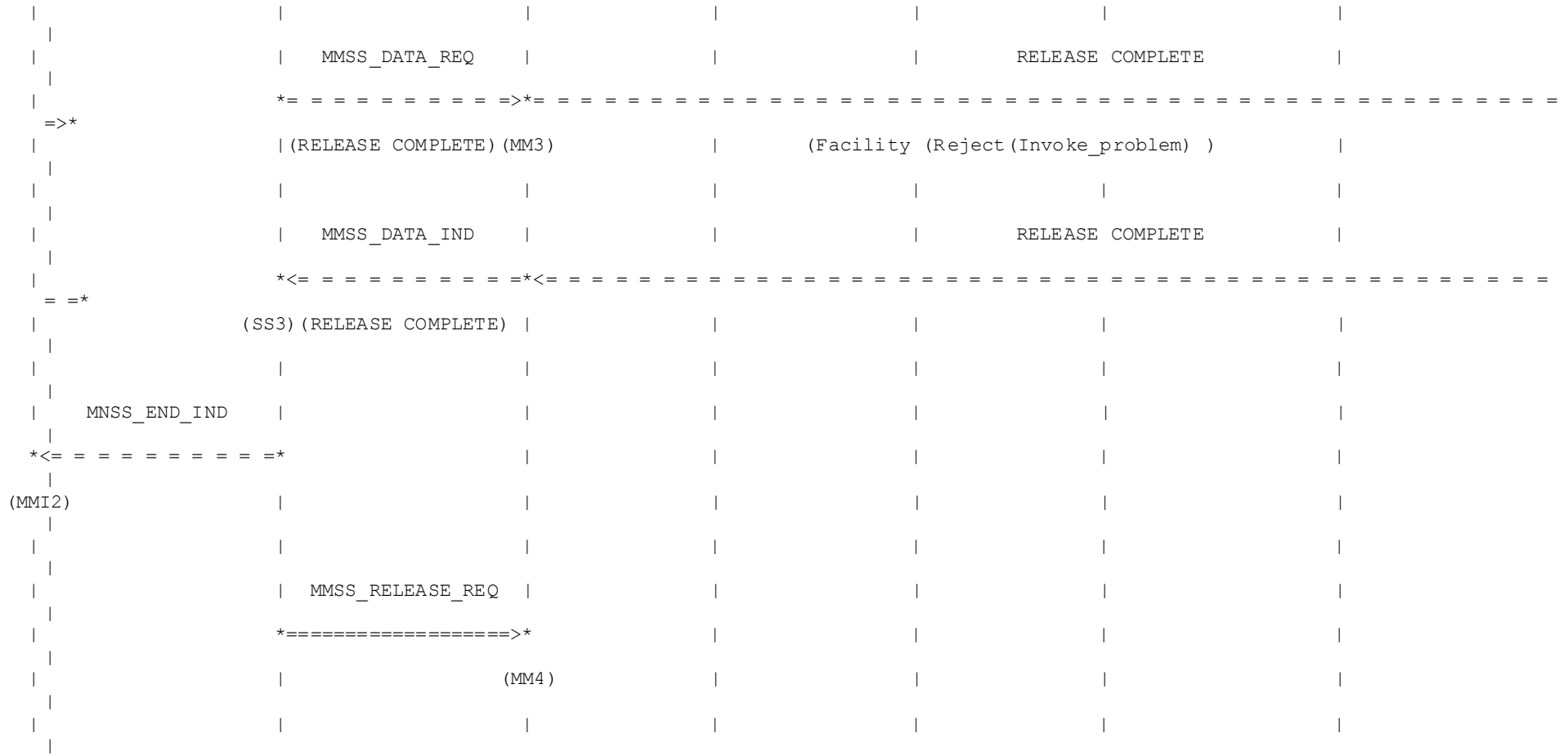
(RRLP 1)
The network starts an RRLP-Measure Position Request. The component includes QoS, other instructions, and possible assistance data. The RRLP message contains a reference number of the request. The RRLP illustration in this MSC is simplified, no dependencies on the kind of location request exist. For a detailed overview see MSC RRLP.

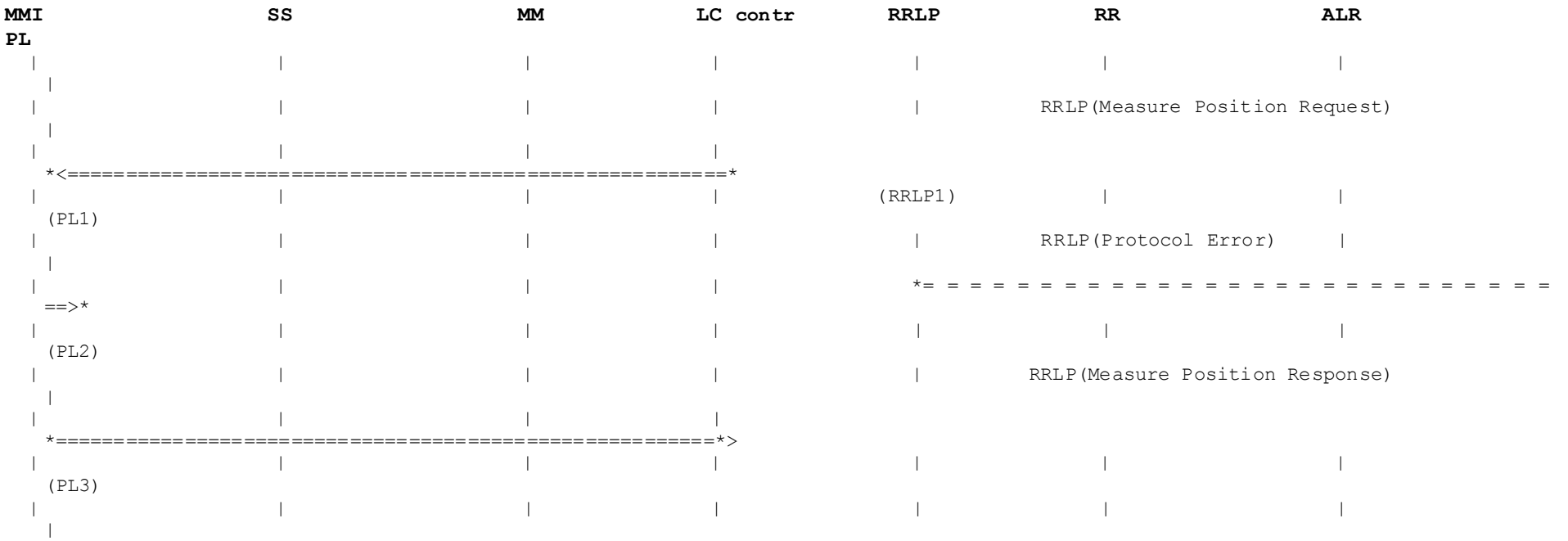
(PL 1)
The MS sends a RRLP message containing the Protocol Error component to the SMLC, if there is a problem that pretends the MS to receive a complete and understandable Measure Position Request component. The RRLP message contains the reference number included in the Measure Position Request received incomplete.

(PL 2)
RR sends the RRLP-Measure Position Response message to the network.

A.6. MSC MT-LR


MMI
SS
MM
LC contr
RRLP
RR
ALR
PL
MMSS_ESTABLISH_IND
REGISTER
(SS1) (REGISTER)
(Facility (Invoke=LCS-LocationNotification))
MNSS_BEGIN_IND
(MMI1)
MNSS_END_REQ
(SS2)
MMSS_DATA_REQ
RELEASE COMPLETE
(RELEASE COMPLETE)(MM1)
(Facility (Return result=LCS-LocationNotification))
MMSS_DATA_REQ
RELEASE COMPLETE
(RELEASE COMPLETE)(MM2)
(Facility (Return error(Error))


MMSS_DATA_REQ
RELEASE COMPLETE
(RELEASE COMPLETE)(MM3)
(Facility (Reject(Invoke_problem))
MMSS_DATA_IND
RELEASE COMPLETE
(SS3)(RELEASE COMPLETE)
MNSS_END_IND
(MMI2)
MMSS_RELEASE_REQ
(MM4)


MMI
SS
MM
LC contr
RRLP
RR
ALR
PL
RRLP(Measure Position Request)
(RRLP1)
(PL1)
RRLP(Protocol Error)
==>*
(PL2)
RRLP(Measure Position Response)
(PL3)

(SS 1)
The network invokes a location notification procedure by sending a REGISTER message containing a LCS-LocationNotification invoke component to the MS.

(MMI 1)
SS checks the message type and the transaction identifier. If it is a LCS-LocationNotification invoke component, SS forwards the content (facility information) to MMI.

(SS 2)
The MMI sends the result of the LCS-LocationNotification invoke to SS.

(MM 1)
In case of privacy verification the MS shall respond to the request by sending a RELEASE COMPLETE message containing the mobile subscriber's response in a return result component. In the case of location notification no response is required from the MS, the MS shall terminate the dialoque by sending a RELEASE COMPLETE message containing a LocationNotification return result.

(MM 2)
If the MS is unable to process the request received from the network, it shall return an error indication by sending a RELEASE COMPLETE message containing a return error component.

(MM 3)
If one of the components received from the network is incorrect, the MS return a reject indication by sending a RELEASE COMPLETE message containing a reject component.

(SS 3)
If the timer expires in the network before any response from the MS, the Network shall interprets this by applying the default treatment defined in GSM 03.71 and release the connection.

(MMI 2)
SS decodes the message and forwards the content to MMI.

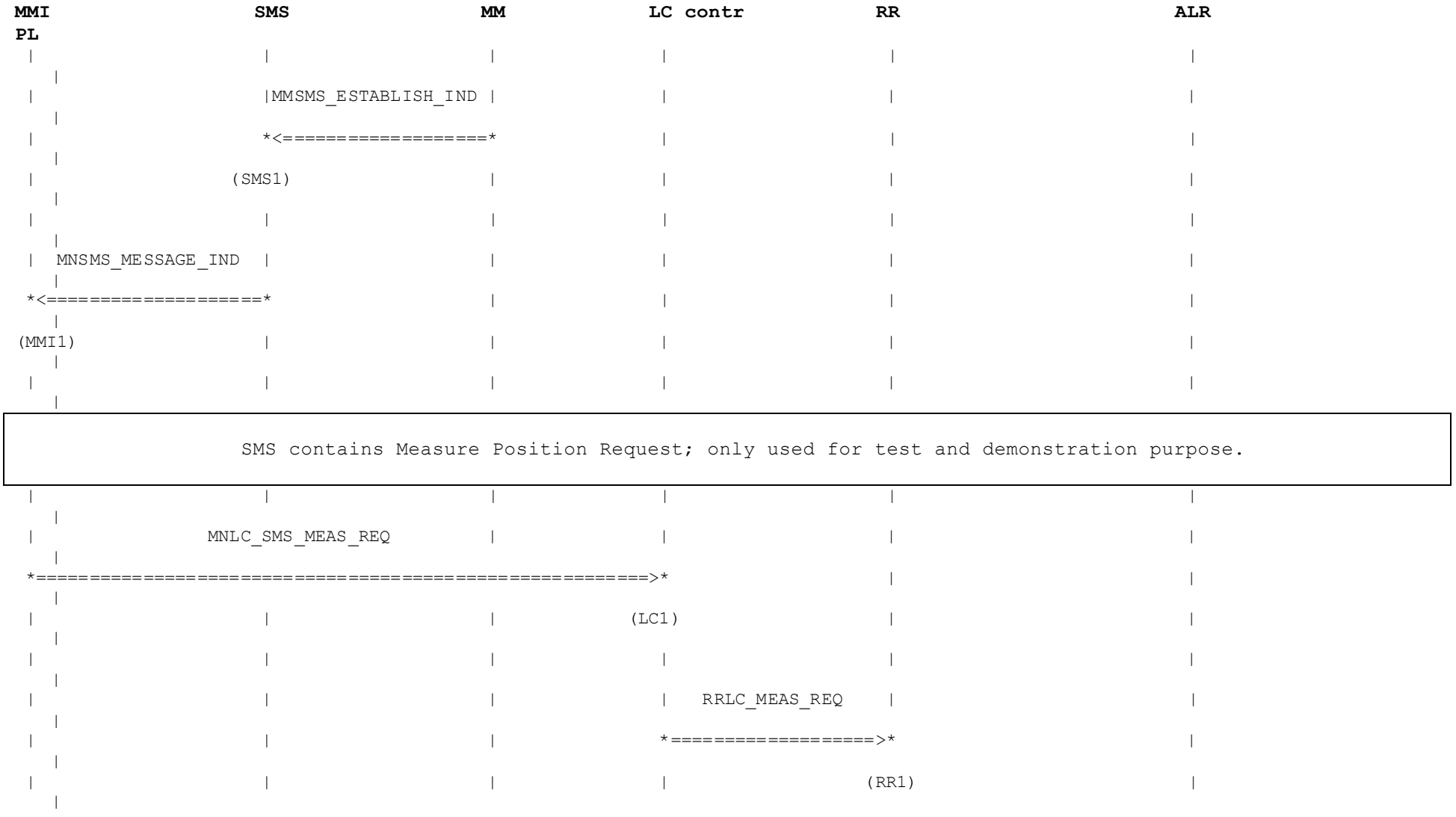
(MM 4)
MM is informed about the end of transaction.

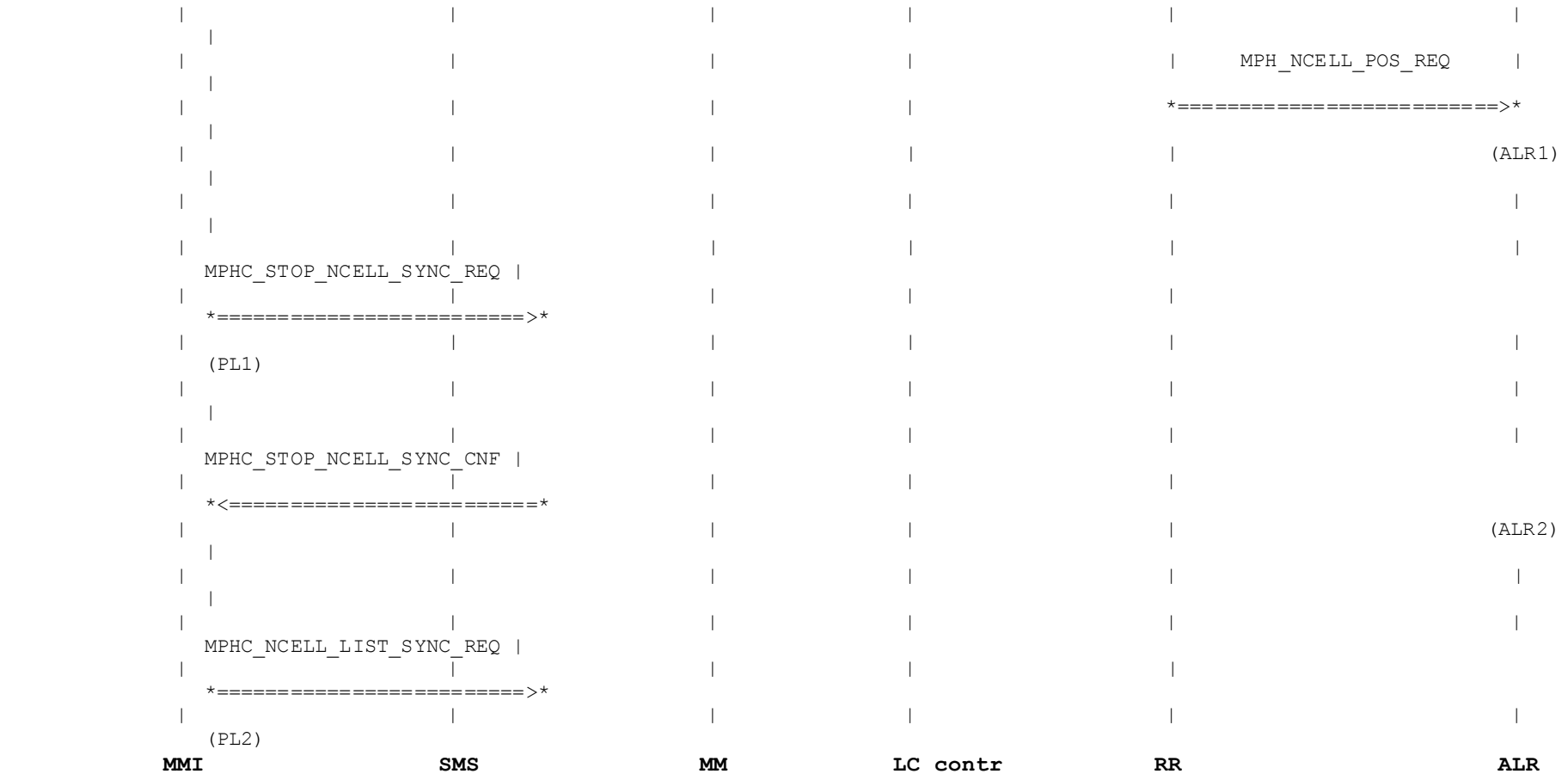
(RRLP 1)
The network starts an RRLP-Measure Position Request. The component includes QoS, other instructions, and possible assistance data. The RRLP message contains a reference number of the request. The RRLP illustration in this MSC is simplified, no dependencies on the kind of location request exist. For a detailed overview see MSC RRLP.

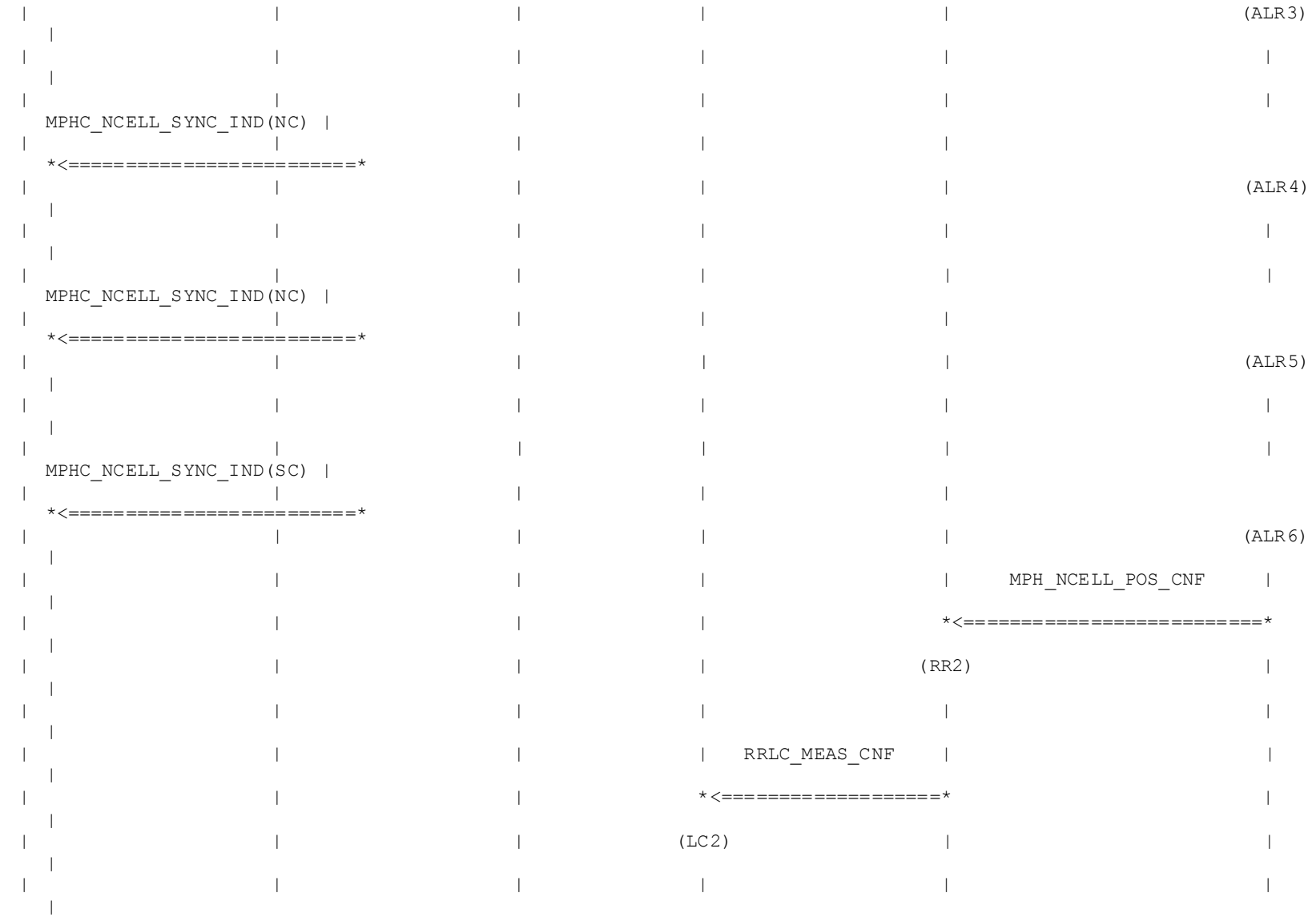
(PL 2)
The MS sends a RRLP message containing the Protocol Error component to the SMLC, if there is a problem that pretends the MS to receive a complete and understandable Measure Position Request component. The RRLP message contains the reference number included in the Measure Position Request received incomplete.

(PL 3)
RR sends the RRLP-Measure Position Response message to the network.

A.7. MSC SMS Measure Position Request




MPH_NCELL_POS_REQ
(ALR1)
MPHC_STOP_NCELL_SYNC_REQ
(PL1)
MPHC_STOP_NCELL_SYNC_CNF
(ALR2)
MPHC_NCELL_LIST_SYNC_REQ
(PL2)
MMI
SMS
MM
LC contr
RR
ALR
PL
MPHC_NCELL_SYNC_IND(SC)


(ALR3)
MPHC_NCELL_SYNC_IND(NC)
(ALR4)
MPHC_NCELL_SYNC_IND(NC)
(ALR5)
MPHC_NCELL_SYNC_IND(SC)
(ALR6)
MPH_NCELL_POS_CNF
(RR2)
RRLC_MEAS_CNF
(LC2)


MNLC_SMS_MEAS_CNF
(MMI2)
MNSMS_SUBMIT_REQ
(SMS2)

(SMS 1)
MM indicates establishment of a SMS connection. This initial primitive contains a CP DATA message. Depending on the protocol identifier, the data-coding scheme and the configured modi SMS decides that the message shall be processed immediately and not stored.

(MMI 1)
The message is passed to MMI for immediate processing.

(LC 1)
The MMI checks the content of the message and sends a request to LC in case of a SMS based Measure Position Request.

(RR 1)
LC starts an additional measurement request.

(ALR 1)
RR starts the measurement request by sending MPH_NCELL_POS_REQ to ALR.

(PL 1)
Before starting EOTD monitoring, ALR must stop neighbourcell monitoring process with a MPHC_STOP_NCELL_SYNC_REQ message for the active list.

(ALR 2)
Layer 1 confirms the nc monitoring process.

(PL 2)
ALR starts an EOTD monitoring session for the serving cell and up to 12 neighbour cells.

(ALR 3)
Layer1 sends the first monitoring results (serving cell) to ALR.

(ALR 4)
Layer1 sends the first monitoring results for the neighbour cells to ALR. Up to 12 neighbour cells are observed.

(ALR 5)
Layer1 sends the last monitoring results for the neighbour cells to ALR.

(ALR 6)
Layer1 sends again monitoring results for the serving cell to ALR.

(RR 2)

The monitoring results are passed to RR.

(LC 2)
RR passes the results to LC. The monitoring data is processed inside the LC.

(MMI 2)
The Cursor ™ module processes all monitored data. The data is packed and formatted in a single SMS.

(SMS 2)
The MMI send the Measure Position Response message to the network.

(MMI 2)
The Cursor ™ module processes all monitored data. The data is packed and formatted in a single SMS.

(SMS 2)
The MMI send the Measure Position Response message to the network.

Appendices

A. Acronyms

DS-WCDMA	Direct Sequence/Spread Wideband Code Division Multiple Access

B. Glossary

International Mobile Telecommunication 2000 (IMT-2000/ITU-2000)	Formerly referred to as FPLMTS (Future Public Land-Mobile Telephone System), this is the ITU's specification/family of standards for 3G. This initiative provides a global infrastructure through both satellite and terrestrial systems, for fixed and mobile phone users. The family of standards is a framework comprising a mix/blend of systems providing global roaming. <URL: http://www.imt-2000.org/>