TEXAS INSTRUMENTS

Technical Document

GSM PROTOCOL STACK

MESSAGE SEQUENCE CHARTS

MM

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         Completion of Calls to Busy Subscriber (CCBS); Service Description; Stage3, ETSI

1.2 Abbreviations

AGCH   Access Grant Channel
BCCH   Broadcast Control Channel
BS   Base Station
BSIC   Base Station Identification Code
CBCH   Cell Broadcast Channel
CBQ   Cell Bar Qualify
CC   Call Control
CCBS   Call Completion to Busy Subscriber
CCCH   Common Control Channel
CCD   Condat Coder Decoder
CKSN   Ciphering Key Sequence Number

CM	Connection Management
C/R	Command / Response
C1	Path Loss Criterion
C2	Reselection Criterion
DCCH	Dedicated Control Channel
DISC	Disconnect Frame
DL	Data Link Layer
DM	Disconnected Mode Frame
EA	Extension Bit Address Field
EL	Extension Bit Length Field
EMMI	Electrical Man Machine Interface
F	Final Bit
FACCH	Fast Associated Control Channel
FHO	Forced Handover
GP	Guard Period
GSM	Global System for Mobile Commmunication
HPLMN	Home Public Land Mobile Network
I	Information Frame
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
Kc	Authentication Key
L	Length Indicator
LAI	Location Area Information
LPD	Link Protocol Discriminator
M	More Data Bit
MCC	Mobile Country Code
MM	Mobility Management
MMI	Man Machine Interface
MNC	Mobile Network Code
MS	Mobile Station
NCC	National Colour Code
NECI	New Establishment Causes included
N(R)	Receive Number
N(S)	Send Number
OTD	Observed Time Difference
P	Poll Bit
PCH	Paging Channel
PDU	Protocol Description Unit
P/F	Poll / Final Bit
PL	Physical Layer
PLMN	Public Land Mobile Network
RACH	Random Access Channel
RAND	RANDom number (used for authentication)
REJ	Reject Frame
RNR	Receive Not Ready Frame
RR	Radio Resource Management
RR	Receive Ready Frame
RTD	Real Time Difference
SABM	Set Asynchronous Balanced Mode
SACCH	Slow Associated Control Channel
SAP	Service Access Point
SAPI	Service Access Point Identifier
SDCCH	Slow Dedicated Control Channel
SIM	Subscriber Identity Module
SMS	Short Message Service
SMSCB	Short Message Service Cell Broadcast
SRES	Signed RESponse (authentication)
SS	Supplementary Services

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TCH	Traffic Channel
TCH/F	Traffic Channel Full Rate
TCH/H	Traffic Channel Half Rate
TDMA	Time Division Multiple Access
TMSI	Temporary Mobile Subscriber Identity
UA	Unnumbered Acknowledgement Frame
UI	Unnumbered Information Frame
VPLMN	Visiting Public Land Mobile Network
V(A)	Acknowledgement State Variable
V(R)	Receive State Variable
V(S)	Send State Variable

1.3 Terms

Entity	Program which executes the functions of a layer
Message:	A message is a data unit which is transferred between the entities of the same layer (peer-to-peer) of the mobile and infrastructure side. Message is used as a synonym to protocol data unit (PDU). A message may contain several information elements.
Primitive:	A primitive is a data unit which is transferred between layers on one component (mobile station or infrastructure). The primitive has an operation code which identifies the primitive and its parameters.
Service Access Point:	A Service Access Point is a data interface between two layers on one component (mobile station or infrastructure).

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2   Overview

This section offers a brief description of the different layers which constitute the mobile station Protocol Stack. It is also intended to offer an overview of the intersystem interface. The Protocol Stacks are used to define the functionality of the GSM protocols for interfaces. The GSM specifications are normative when used to describe the functionality of interfaces, but the stacks and the subdivision of protocol layers do not imply or restrict any implementation.

2.1   PL - Physical Layer

The base of the Protocol Stack rests on the physical layer.

2.2   DL - Data Link

The Data Link Layer (DL) is used to handle an acknowlowdged connection between mobile and base station. The LAPDm protocol is used.

2.3   RR - Radio Resource

Radio Resource (RR) manages the resources of the air-interface. That means configuration of physical layer, cell selection and cell reselection, data transfer, RR-Connection handling.

2.4   MM - Mobility Management

Mobility Management (MM) handles registration aspects for the mobile station. It detects changes of location areas and updates a mobile station in the new location area.

2.5   CC - Call Control

Call Control (CC) provides the call functionality. This includes call establishment, call maintenance procedures like Hold, Retrieve or Modify, and call disconnection.

2.6   SS - Supplementary Services

Supplementary Services (SS) handles all call independent supplementary services like call forwarding or call barring.

2.7   SMS - Short Message Services

Short Message Services (SMS) is used for sending and receiving point-to-point short messages. Additionally the reception of cell broadcast short messages is included.
Call Control (CC), Supplementary Services (SS) and Short Message Services (SMS) together are referred to as Connection Management (CM) sometimes.

2.8   MMI - Man Machine Interface

The man machine interface (MMI) is the interface to the user. Normally it is connected with a keypad as input device and a display as output device. In G23, there is a AT Command Interpreter (ACI), therefore, sometimes the MMI is also referred to as ACI in the present document if "the layer above layer 3" is to be identified.
Between the several entities data interfaces are defined. These data interfaces are called Service Access Points (SAPs), indicating that an upper layer uses the services of a lower layer.
The GSM specification do not set out any implementation of the Protocol Stack. The following diagrams show the implementation described in all these documents for the mobile station. All entities

except the Man Machine Interface and Physical Layer are implemented as part of the Protocol Stack - with ACI seen as an integral part of the stack in almost all cases.
For GPRS, there are more entities.

2.9 GRR (RLC/MAC) – Radio Link Control/Medium Access Control

This layer contains two functions: The Radio Link Control function provides a radio-solution-dependent reliable link. The Medium Access Control function controls the access signalling (request and grant) procedures for the radio channel, and the mapping of LLC frames onto the GSM physical channel.

2.10 LLC – Logical Link Control

The LLC entity provides multiple highly reliable logical links for asynchronous data transfer between the MS and the network. It supports variable-length information frames, acknowledged and unacknowledged data transfer, flow and sequence control, error detection and recovery, notification of unrecoverable errors, user identity confidentiality, and ciphering of user and signaling data.

2.11 GMM – GPRS Mobility Management

The GMM entity provides procedures for the mobility of the MS, such as informing the network of its present location, and user identity confidentiality. It manages the GMM context (attach, detach, routing area updating), supports security functions such as authentication of user and MS, controls ciphering of data, and initiates the response to paging messages.

2.12 SM – Session Management

The main function of the session management (SM) is to support PDP context handling of the user terminal. Session Management activates, modifies and deletes the contexts for packet data protocols (PDP). Session Management services are provided at the SMREG-SAP and the SNSM-SAP for anonymous and non-anonymous access. The non-anonymous and anonymous access procedures for PDP context activation and PDP context deactivation are available at the SMREG-SAP. In addition there exists a PDP context modification for non-anonymous PDP contexts.

2.13 SNDCP - Subnetwork Dependant Convergence Protocol

SNDCP carries out all functions related to transfer of Network layer Protocol Data Units (N-PDUs) over GPRS in a transparent way. SNDCP helps to improve channel efficiency by means of compression techniques. The set of protocol entities above SNDCP consists of commonly used network protocols. They all use the same SNDCP entity, which then performs multiplexing of data coming from different sources to be sent using the service provided by the LLC layer.

2.14 GACI – GPRS Application Control Interface

The GACI is the GPRS extension of the ACI. It is specified in GSM 07.07 and 07.60. It is responsible for processing of the GPRS related AT Commands to setup, activate and deactivate the PDP context parameter. It also provides functionality for the interworking between GMM/SM/SNDCP and a packet oriented protocol like PPP.

2.15 GSMS - GPRS Short Message Service

Like GACI, GSMS, the GPRS Short Message Service, is also not a new entity of its own, but it is the GSM SMS entity enhanced by GPRS functionality.
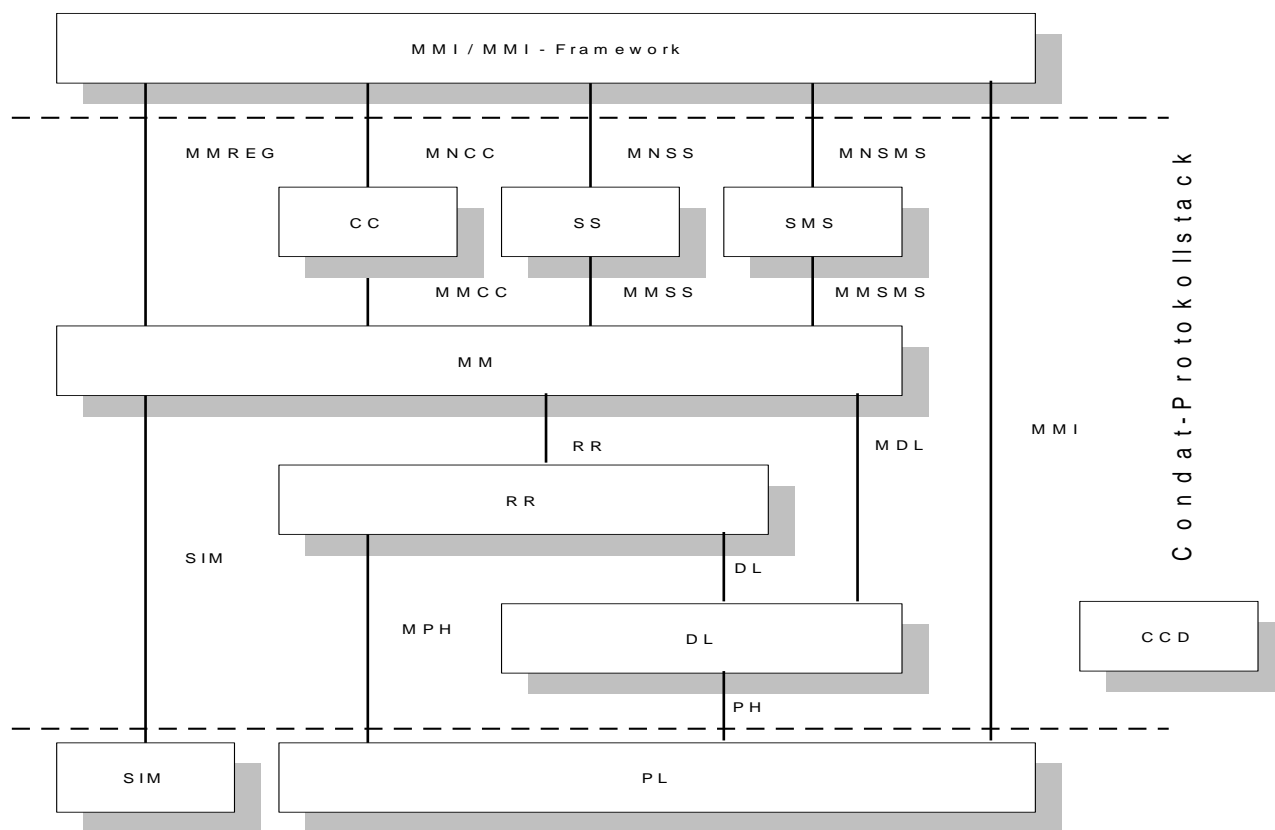
Figure 1: Mobile-station protocol architecture (GSM only)

Figure 2: Mobile-station protocol architecture (GSM+GPRS)
This document describes the services offered by the mobility management entity.
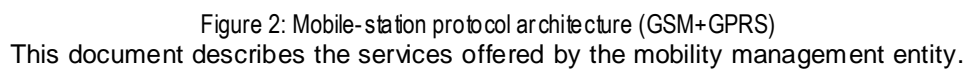
3 Introduction

3.1 Mobility Management Services

The services offered by mobility management are described in the following:

Registration
After power-on or SIM insertion the mobile station searches for a cell and tries to register on it. Selecting a network is the sense of the registration procedure.

Normal Location Updating
If the mobile station is not registered by the network or changes a location area a normal location updating is processed. That means the registration by the network is updated.

Periodic Location Updating
If the network uses periodic location updating this procedure is used by the mobile station to update its registration by the network in periodic times.

IMSI Attach
If indicated by the network the mobile station updates its registration after initial cell selection allought the SIM card shows the updated state.

IMSI Detach
If indicated by the network the mobile station de-registers itself during SIM removing or power-off.

TMSI Reallocation
The TMSI Reallocation procedure is used by the network to assign a new or changed temporary subscriber identity to the mobile station.

Authentication
The authentication procedure is used to calculate and compare the authentication parameter.

Identification
The base station uses the identication procedure to request the various identifications from a mobile station.

MM-Connection Management
MM handles the various connections from call control, supplementary services and short message services.

Net Request
The net request procedure requests all available networks and presents it to the man machine interface.

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3.2 Dynamic Configuration

For mobility management (MM) a lot of dynamic configurations are defined. That means it is possible at run-time to change in behaviour of MM by sending of a string from a test device to MM.

MM uses a keyword table to interpretate the strings. The strings have the following general format:

<keyword> = (parameter 1, parameter 2, ...)

Keywords without parameters are defines only by using the keyword. For keywords with one parameter the bracket aren´t necessary.

The following table is an overview of the possible configurations:

keyword	Parameter
TIMER_SET	name value unit
TIMER_RESET	name
TIMER_SPEED_UP	name factor
TIMER_SLOW_DOWN	name factor
TIMER_SUPPRESS	name

If mobility management is used in a multi instances system the dynamic configurations have the parameter instance.

The keywords **TIMER_SET, TIMER_RESET, TIMER_SPEED_UP, TIMER_SLOW_DOWN** and **TIMER_SUPPRESS** are used for manipulting timers. The different timers are identified by their names. The time used by next starting of the timer is manipulated by the dynamic configurations.

3.3 Timer Modi

For each timer of MM it is possible to define a mode by a dynamic configuration. If a timer is started by MM the given start value is manipulated according to the timer mode.

The timer mode **TIMER_SET** defines a new timer value instead of the origin start value.

The default timer mode is **TIMER_RESET** which makes no manipulation of the start value.

TIMER_SPEED_UP is used to speed up a timer by the given factor. The start value is divided by the factor. The minimum time is one unit.

The opposite mode is **TIMER_SLOW_DOWN**. The start value is multiplied by the given factor.

TIMER_SUPPRESS is used to suppress the timer start.

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3.4 States

MM contains different state machines and state variables. Some of these state machines and state variables are very close to ETSI, some others are Condat proprietary. If a state is defined by ETSI and is not implemented or has a somewhat different meaning in the G23 implementation as this is described in the GSM 04.08, this is mentioned in this document. Also the MM overview in GSM 04.08 is not correct, a more accurate picture is given here.
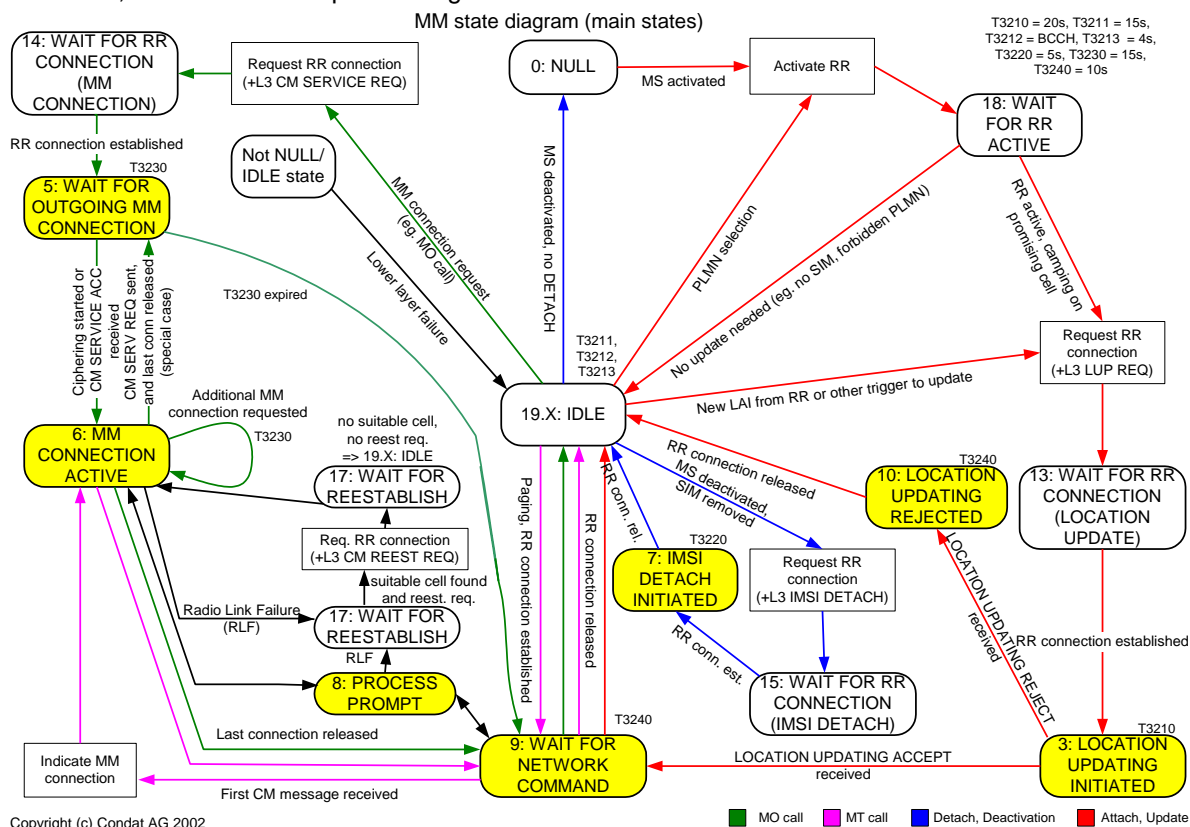
Figure 3: MM state overview

3.4.1 MM Main state machine (GSM+GPRS)

These are the MM main states as described by ETSI in GSM 04.08.

MM_0 (NULL)	The mobile station is inactive (e.g. power down). Important parameters are stored. Only manual action by the user may transfer the MM sublayer to another state.
MM_3 (LOCATION UPDATING INITIATED)	A location updating procedure has been started and the MM awaits a response from the network. The timer T3210 is running. In the G23M implementation the state is used somewhat different. Either the timer T3210 is running (normal case) or the timer T3210 has expired, the RR connection has been aborted and MM is waiting in the state MM_3 for the release of the RR connection (exceptional case).
MM_5 (WAIT FOR OUTGOING MM CONNECTION)	The MM connection establishment has been started, and MM awaits a response from the network. The timer T3230 is running. In the G23M implementation the state is used somewhat different. Either the timer T3230 is running (normal case) or the timer T3230 has expired,

	the RR connection has been aborted and MM is waiting in the state MM_5 for the release of the RR connection (exceptional case).
MM_6 (MM CONNECTION ACTIVE)	The MM sublayer has a RR connection to its peer entity on the network side. One or more MM connections are active.
MM_7 (IMSI DETACH INITIATED)	The IMSI detach procedure has been started. The timer T3220 is running.
	In the G23M implementation the state is used somewhat different. Either the timer T3220 is running (normal case) or the timer T3220 has expired, the RR connection has been aborted and MM is waiting in the state MM_7 for the release of the RR connection (exceptional case).
MM_8 (MM_PROCESS_PROMPT)	The message CM SERVICE PROMPT was received in a compatible protocol state and with compatible parameters. A CM entity is informed by MMCC_PROMPT_IND, an answer from this CM entity (rejection or assignment of a mobile originated transaction identifier) is expected.
MM_9 (WAIT FOR NETWORK COMMAND)	The MM sublayer has a RR connection to its peer entity in the network, but no MM connection is established. The Mobile Station is passive, awaiting further commands from the network. The timer T3240 may be running.
	In the G23M implementation the state is used somewhat different. Either the timer T3240 is running (normal case) or the timer T3240 has expired, the RR connection has been aborted and MM is waiting in the state MM_9 for the release of the RR connection (exceptional case).
MM_10 (LOCATION UPDATE REJECTED)	A location updating procedure has been rejected and RR connection release is awaited. The timer T3240 is running.
	In the G23M implementation the state is used somewhat different. Either the timer T3240 is running (normal case) or the timer T3240 has expired, the RR connection has been aborted and MM is waiting in the state MM_10 for the release of the RR connection (exceptional case).
MM_13 (WAIT FOR RR CONNECTION (LUP))	The MM sublayer has requested RR connection establishment for starting the location updating procedure.
MM_14 (WAIT FOR RR CONNECTION (MM-CONNECTION)	The MM sublayer has requested RR connection establishment for starting the MM connection establishment.
MM_15 (WAIT FOR RR CONNECTION (IMSI DETACH)	The MM sublayer has requested RR connection establishment for starting the IMSI detach procedure.
MM_17 (WAIT FOR REESTABLISH)	A lower layer failure has occurred and reestablishment may be performed from the disturbed CM layer entities.
MM_18 (WAIT FOR RR ACTIVE)	The MM sublayer has requested activation of the RR sublayer.
MM_19_1 (IDLE, NORMAL SERVICE)	Valid subscriber data are available, update status is U1, a cell is selected that belongs to the LA where the subscriber is registered. In this state, all requests from the CM layers are treated normally. In the G23 implementation, this state may also be

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	entered if the update status is U1 (updated) and a cell is selected that does not belong to the LA where the subscriber is registered and a location updating procedure is needed. This is due to the lack of MM_19_6 in the implementation for GSM.
MM_19_2 (IDLE, ATTEMPTING TO UPDATE)	Valid subscriber data are available, update status is U2 and a cell is selected. Requests from upper layers are accepted. Emergency call requests are treated normally, otherwise the request triggers first a location updating attempt in the selected cell, and then triggers the needed procedure only in case of successful location updating, otherwise the request is rejected.
MM_19_3 (IDLE, LIMITED SERVICE)	Valid subscriber data are available, update status is U3, and a cell is selected, which is known not to be able to provide normal service. Only emergency services are offered. In the G23 implementation, the MM update status is a direct copy from the update status on the SIM and there is no distinct "update status". No assumption can be made about the update status on the SIM for the G23 protocol stack only from the MM main state, as it is possible that the mobile is IDLE updated in some other location area, but has only temporary lost full service and will be in full service without location updating procedure after cell selection from RR.
MM_19_4 (IDLE, NO IMSI)	No valid subscriber data (no SIM, or the SIM is not considered valid by the ME), and a cell is selected. Only emergency services are offered.
MM_19_5 (IDLE, NO CELL AVAILABLE)	No cell can be selected. This state is entered after a first intensive search failed (state 19.7). Cells are searched at a low rhythm. No services are offered. In G23, the first intensive search is done in state 8. The states 19.7 and 19.8 are only entered if the the user manually requested a PLMN search.
MM_19_6 (IDLE, LOCATION UPDATE NEEDED)	Valid subscriber data are available, and for some reason a location updating must be done as soon as possible (for instance update status is U1 but the selected cell is not in the registered LA, or the timer has expired, ...). This state is usually of no duration, but can last, e.g., in the case of access class blocking. In G23 this state is only implemented as distict state if GPRS is present, and then it is entered only if MM detected after cell selection in RR that either an IMSI ATTACH or NORMAL UPDATED is necessary, but GMM didn't reacted on this event.
MM_19_7 (IDLE, PLMN SEARCH)	The MS is searching for PLMNs, and the conditions for state 19.8 are not met. This state is ended when either a cell is selected (the new state is 19.1, 19.3 or 19.6), or when it is concluded that no cell is available for the moment (the new state is 19.5).
MM_19_8 (IDLE, PLMN SEARCH, NORMAL SERVICE)	Valid subscriber data are available, update status is U1, a cell is selected which belongs to the LA where the subscriber is registered, and the MS is searching for PLMNs. This state is ended when either a cell is selected (the new state

is 19.1, 19.3 or 19.6), or when it is concluded that no cell is available for the moment (the new state is 19.5).

MM_20 (WAIT FOR ADD. OUTGOING MM CONNECTION)   The MM connection establishment for an additional MM connection has been started, and MM awaits response from the network.

In G23, this state is not implemented directly at first glance, but it exist as substate of MM_6 if the boolean variable *wait_for_accept* equals TRUE. As this has no advantages in comparison with the distinct ETSI defined state, this may change in a future release.

MM_21 (MM CONN. ACTIVE, GROUP TRANSMIT MODE)   (Only applicable for mobile stations supporting VGCS talking:) The MM sublayer has a RR connection on the VGCS channel to its peer entity on the network side. Only one MM connection is active.

As G23 does not support VGCS talking, this state doesn't exist in the G23 implementation, but as it is an ETSI defined state it is mentioned here.

MM_22 (WAIT FOR RR CONN., GROUP TRANSMIT MODE)   (Only applicable for mobile stations supporting VGCS talking:) The MM sublayer has requested to perform an uplink access on the VGCS channel.

As G23 does not support VGCS talking, this state doesn't exist in the G23 implementation, but as it is an ETSI defined state it is mentioned here.

MM_23 (LOCATION UPDATING PENDING)   (Only applicable for GPRS MS operation modes A and B; not shown in figure 4.1a) A location updating has been started using the combined GPRS routing area updating procedure.

This state is only present if a GPRS enabled G23 is shipped, but even then it is in the current implementation never entered, as it was seen during the implementation phase that the approach taken to support GPRS doesn't need this state. The state may disappear in the future from the G23 implementation.

MM_24 (IMSI DETACH PENDING)   (Only applicable for GPRS MS operation modes A and B; not shown in figure 4.1a) An IMSI detach for non-GPRS services has been started using the combined GPRS detach procedure at not switching off.

This state is only present if a GPRS enabled G23 is shipped, but even then the same applies as for MM_23.

3.4.2 MM service state variable (GSM+GPRS)

The MM service state is a state variable (in contradiction to a state of a SDL process). The MM service state is defined in GSM 04.08.

MM always has to keep track of its service state to some extend. In the G23 MM implementation the IDLE state is not implemented as state number 19 and different types of IDLE distinguished by a distinct service state as proposed by ETSI, but all MM IDLE states are implemented as distict states (means every distinct IDLE state has assigned a distinct ordinal number) and there is no service state at first glance. So G23 MM has in any IDLE state the implicit information about its service state directly from the IDLE state itself. This is different in the non-IDLE states where we cannot tell from the state itself in which service state MM is. This becomes obvious for e.g. MM_WAIT_FOR_NW_CMD if we are coming back from an emergeny call, here MM cannot tell from the number of the state itself whether the service state is NORMAL SERVICE or LIMITED SERVICE, but MM needs this information

after the release of the RR connection to enter the correct IDLE state. This problem is solved by re-membering the exact IDLE state (which is 19.1 to 19.6 in ETSI's numbering scheme) before leaving IDLE.

So at first glance there is no service state in the implementation, but at second glance there is a service state to a sufficient extend, either implecitely from the MM main state or indirectly from the stored MM IDLE state MM had before it left IDLE state in combination with some other informations MM stores, e.g. the mobile's update state, the informations about the selected cell and whether a valid SIM is inserted.

In G23, the service states SEARCH FOR PLMN, NORMAL SERVICE and SEARCH FOR PLMN only exist in combination with IDLE states 19.7 and 19.8. In case there is the request for a RR connection on a MT connection, RR stops searching for a network immediately and will not automatically restart searching if it comes back from dedicated mode. So the service states SEARCH FOR PLMN, NORMAL SERVICE and SEARCH FOR PLMN dont't make any sense in any non-IDLE MM state. In case MM enters the states 19.7 (IDLE, PLMN SEARCH) or 19.8 (IDLE, PLMN SEARCH, NORMAL SERVICE) MM remembers the previous IDLE state as it was leaving IDLE state.

3.4.3 CM Establishment state variable (GPRS only)

The CM Establishment state machine is only present if a GPRS enabled protocol stack is shipped and in this case only used if GPRS is activated by the mobile used. It is used to control CM establishment and to keep track whether CM establishment is allowed by GMM. This state variable is not defined by ETSI, but a suitable solution for GPRS integration in the G23 MM implementation.

MM state diagram (CM GPRS auxiliary)
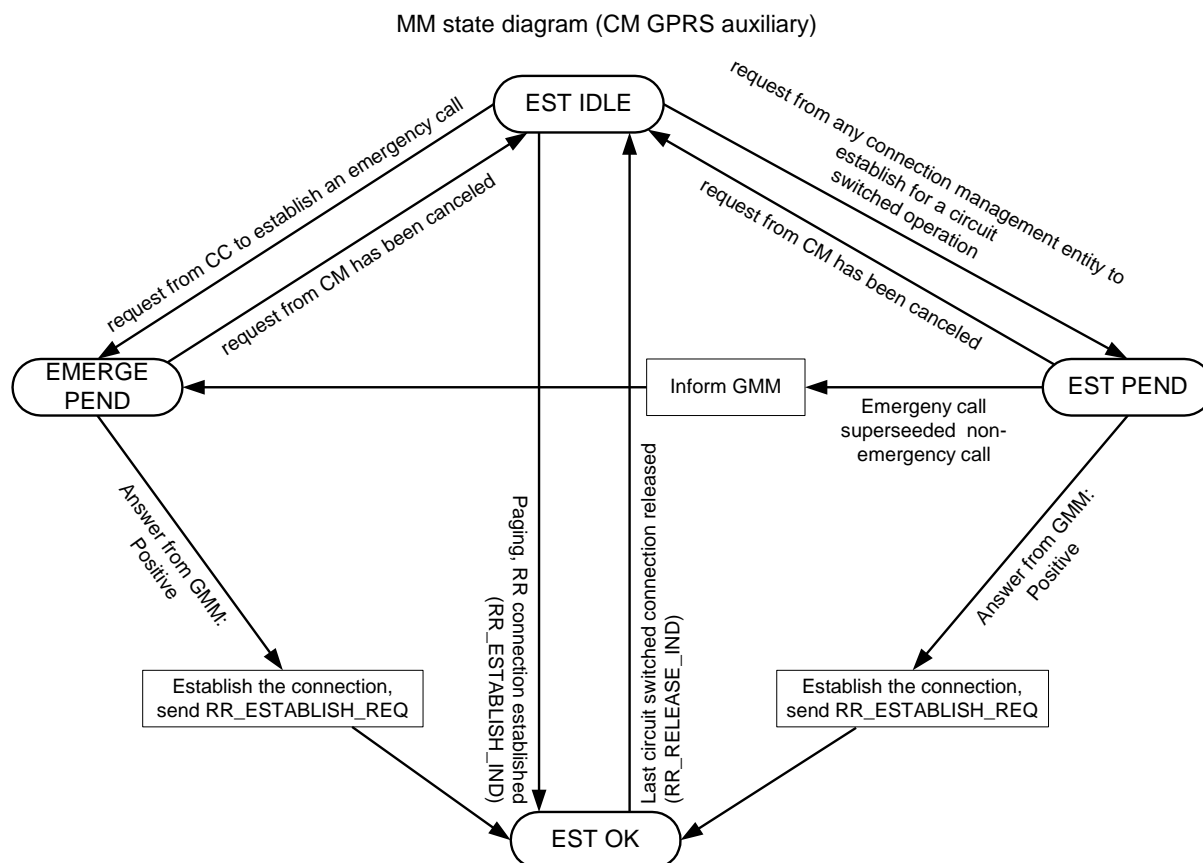
Figure 4: MM auxiliary state overview for circuit switched establishment with GPRS

CM_GPRS_EST_IDLE	No request for a CM establishment has been made by one of the CM entities and no MT connection has been performed by the network.
CM_GPRS_EST_PEND	A CM entity has requested a CM connection. As GPRS is present and active, it is not allowed for MM to immediately establish a RR connection to fulfill the CM request, first GMM has to be informed about the wish to establish a RR connection for MM by sending a MMGMM_CM_ESTABLISH_IND primitive to GMM. This allows GMM to prepare for a circuit switches connection. MM is waiting for the response of GMM, the parameters for the CM connection have been stored.
CM_GPRS_EMERGE_PEND	This is basically the same as CM_GPRS_EST_PEND, but an establish request for an emergency call has been received from CC.
CM_GPRS_EST_OK	GMM is informed about the request from CM to establish a circuit switched connection and a positive response from GMM was received.

3.4.4 Registration Type State Variable (GPRS only)

The Registration Type state variable is a state variable in G23 for the reason that this variable is important for MM operation if GPRS is shipped. It was made a state variable from an ordinary variable for the fact that this in the G23 implementation eases keeping track in the trace-files of the variable.

Figure 4: MM auxiliary state overview for circuit switched establishment with GPRS

MM state diagram (GPRS REG TYPE auxiliary state)
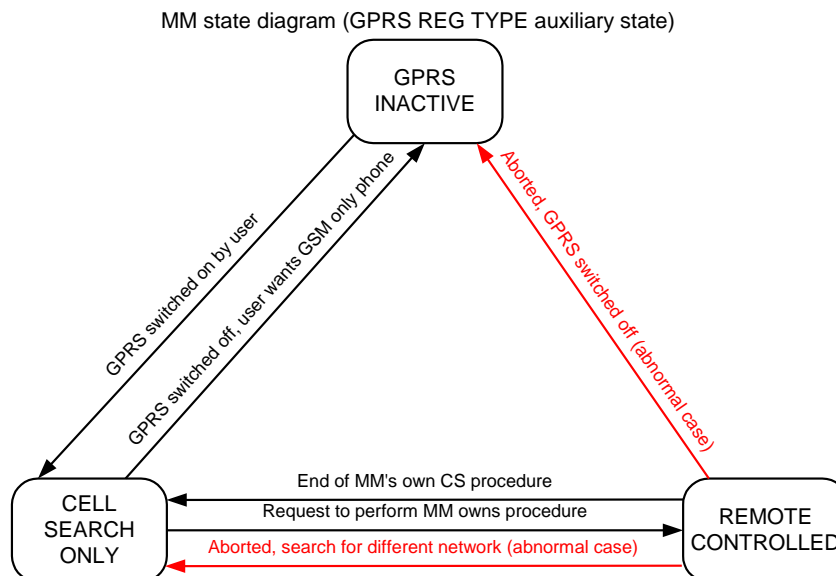
REG_GPRS_INACTIVE	GPRS is inactive. This means, the user currently isn't interested in the GPRS functionality of the mobile and his manually disabled this functionality. The mobile is behaving like a phone with a protocol stack where GPRS was not shipped. There is one exception from this rule, and this is if the network invalidates the SIM. In this case, GMM is informed (e.g. AUTHENTICATION REJECT). If GPRS is only temporary not usable because the selected cell doesn't provide GPRS facilities, but the user didn't disable the GPRS functionality, the state is different from REG_GPRS_INACTIVE. MM is allowed to establish a RR connection without negociation with GMM for CM establishment or its own MM procedures.
REG_REMOTE_CONTROLLED	GPRS is activated by the user (which doesn't mean that the network also supports GPRS, this may or may not be the case). GMM requested MM to perform a MM specific procedure, this may be either a LOCATION UPDATE procedure (ATTACH, NORMAL or PERIODIC UPDATE) or an IMSI DETACH. If this procedure is ended (either sucessful or non-sucessful), the new state is REG_CELL_SEARCH_ONLY.
REG_CELL_SEARCH_ONLY	GPRS is activated by the user, MM has been required to activate RR. Without prior negociation with GMM the MM entity is not allowed to establish any RR connection, either for CM establishment or its own MM specific procedures.

3.4.5 Connection States (GSM+GPRS)

Every CM transaction has its own connection state which has to be maintained by MM. There can be up to 14 transaction identifiers per CM entity, and there are 3 CM entities, a transaction is given by the CM entity which own the transaction and the transaction identifier. The Connection State for each transaction is held by MM in a two-dimensional table, one dimension for the CM entity to which the transaction belongs and one dimension for the transaction identifier.

MM state diagram (Connection Management states for each transaction)
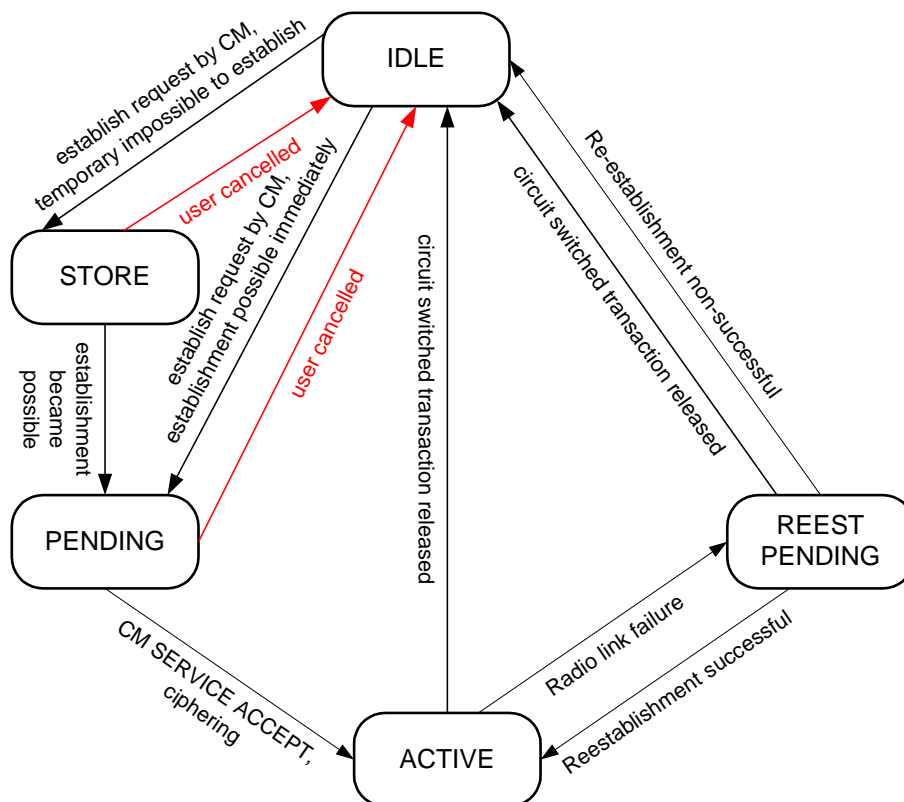
Figure 5: Mobile-station protocol architecture (GSM only)

CM_IDLE	No request is present from CM to establish a MM connection for the transaction nor has such a connection already been established.
CM_PENDING	The CM connection is pending. A connection is pending if the CM SERVICE REQUEST message has been sent to the network, but no answer (e.g. CM SERVICE ACCEPT or CIPHERING MODE COMMAND) from the network has been received yet to answer the request. There can be exactly one pending connection for MM.
CM_ACTIVE	The CM connection becomes active after a CM SERVICE ACCEPT or CIPHERING MODE COMMAND message has been received by the network. The state transition is normally only possible from state CM_PENDING, all other cases are abnormal error cases. The state is left if the CM entity requests the release of the MM connection or RR indicated the release of the RR connection or a radio link failure.
CM_REEST_PENDING	This state is entered from state CM_ACTIVE if the appropriate CM entity has requested the call reestablishment after a radio link failure. This will always be the case for CC in the current implementation and never for SMS and SS.

CM_STORE

The connection request cannot be handled in the present MM state (e.g. the MM main state is WAIT FOR NETWORK COMMAND and MM has to wait for the release of the RR connection and enter IDLE state before a new RR connection can be established for CM service or MM is still waiting for a response from GMM wheter it is allowed to establish a RR connection for CM establishment), but it is expected that this will change within a short amount of time and the connection request from CM can be processed.

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3.5 Mobile Station Configuration

MM reads several records of the permanent memory configuration to get the actual configuration. The following records are read:

- IMEI   the international mobile equipment identity of the mobile station

For details see the document generic target interface description (G23GTI.DOC). In this specification the structure and the use of the permanent memory configuration is described.

MM also needs classmark 2. This is not read from permanent configuration memory anymore by MM itself, but constructed from RFCap which is read in RR. The PCM file CLASS2 is not used anymore by MM. There is a functional interface between MM and RR now to obtain the classmark 1 and class-mark 2 information, the functions are rr_csf_get_classmark1() and rr_csf_get_classmark2().

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4 Registration

4.1 Activation of MS

```
MMI                      MM                   SIM                   RR
 |                        |                    |                     |
 |     MMR REG REQ        |                    |                     |
 *===================>*                    |                     |
 |                     (MM 1)                  |                     |
 |                        |         RR ACTIVATE REQ                  |
 |                        *===============================>*
 |                        |                    |            (RR 1)
 |                        |                    |                     |
```
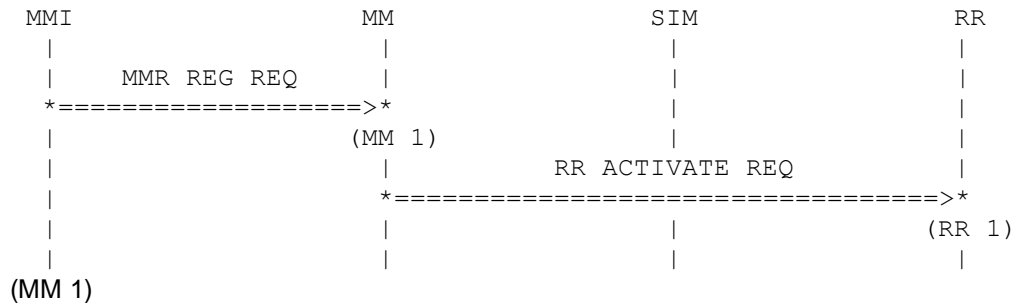
(MM 1)
After power-on MMI starts a cell search for limited service. It is assumed that either no SIM is present in the phone or the SIM is still blocked (e.g., the PIN has not yet been entered).
(RR 1)
RR is activated for the cell search for limited service. That means no plmn is requested. A suitable cell has a path loss criterion C1 greater than zero and is not barred.

4.2 Positive End of Registration Attempt (Limited Service)

```
MMI                      MM                   SIM                   RR
 |                        |                    |                     |
 |                        |         RR ACTIVATE CNF                  |
 |                        *<===============================*
 |                     (MM 1)                  |                     |
 |                        |                    |                     |
 |     MMR NREG IND       |                    |                     |
 |   (limited service)    |                    |                     |
 *<===================*                    |                     |
(MMI 1)                     |                    |                     |
 |                        |                    |                     |
```
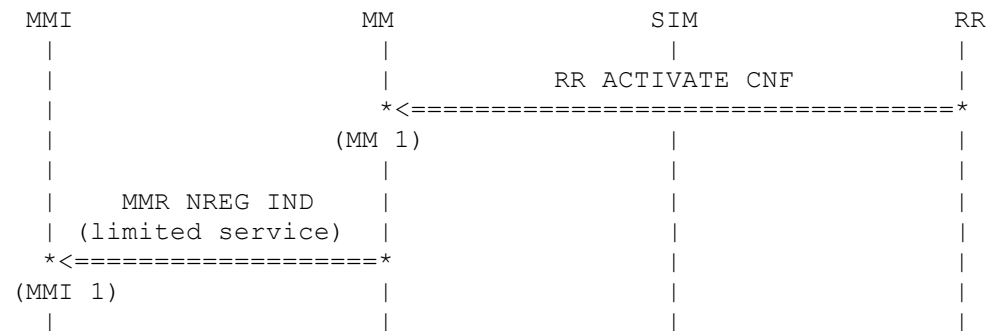
(MM 1)
After detecting a suitable cell for limited service, RR sends a RR ACTIVATE CNF primitive to MM.
(MMI 1)
MMI is informed by a MMR NREG IND primitive with the nreg cause Limited Service.

4.3 SIM Insertion (PLMN Search)

```
MMI                     MM                  SIM                 RR
 |                       |                   |                   |
 |                       |SIM MM INSERT IND| |                   |
 |                       *<===============*                      |
 |                      (MM 1)             |                     |
 |    MMR REG REQ        |                  |                     |
 *==================>*                      |                     |
 |                     (MM 2)               |                     |
 |                       |          RR ACTIVATE REQ              |
 |                       *===============================>*
 |                       |                   |              (RR 1)
 |                       |                   |                   |
```
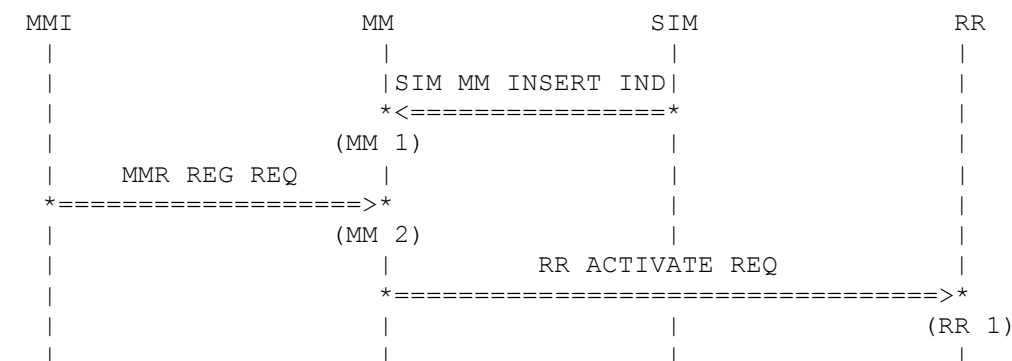
(MM 1)

After SIM insertion the PIN is requested in MMI if necessary. Then MM is informed by the SIM application with SIM MM INSERT IND. This primitive contains the content of several SIM fields.

(MM 2)

MMI starts the cell search.

(RR 1)

The BCCH search for a network is started. Parameter of the SIM card like the IMSI are forwarded to RR.

4.4 Positive End of PLMN Search

```
MMI                     MM                  SIM                RR/DL
 |                       |                   |                   |
 |                       |          RR ACTIVATE CNF             |
 |                       *<===============================*
 |                     (MM 1)               |                   |
 |    MMR REG CNF        |                   |                   |
 *<==================*                       |                   |
(MMI 1)                  |                   |                   |
 |                       *<location updating>                    |
 |                       |                   |                   |
```
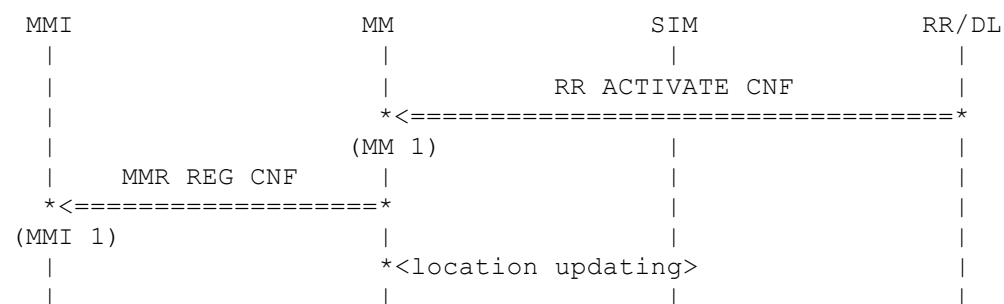
(MM 1)

RR signals a positive end of the BCCH search. That means a cell is camped with a positive path loss criterion C1, not barred and the requested network.

(MMI 1)

The network identification is forwarded to MMI, if a normal SIM card is inserted and the requested PLMN is the HPLMN. Strictly according to GSM it is allowed to signal full service condition after location updating. The condition is send earlier to give the user the feeling to have a fast access to the network. If needed a location updating is started.

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4.5 Negative End, No PLMN available

```
MMI                     MM                  SIM              RR/DL
 |                       |                   |                |
 |                       |           RR ABORT IND             |
 |                      *<===============================*
 |                    (MM 1)              |                |
 |                       |          MDL RELEASE REQ          |
 |                      *===============================>*
 |                       |                   |              (DL 1)
 |      MMR NREG IND      |                   |                |
 |      (no service)      |                   |                |
 *<=================*     |                   |                |
(MMI 1)                   |                   |                |
 |                       |                   |                |
```
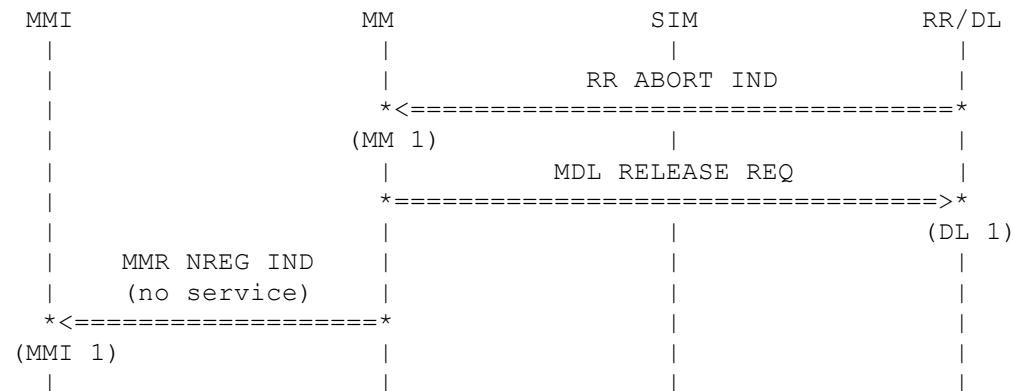
(MMI 1)
If no suitable cell is available RR sends an abort indication to MM. RR indicates no detected PLMNs.
(DL 1)
MM resets the data link layer.
(MMI 1)
The negative result is forwarded to MMI.

4.6 Negative End, PLMN list available
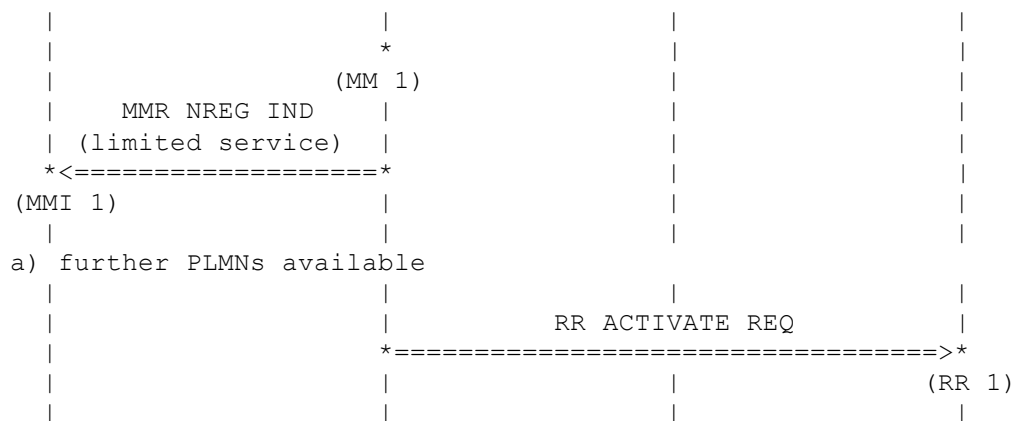
```
 |                       |                   |                |
 |                       *                   |                |
 |                    (MM 1)               |                |
 |      MMR NREG IND      |                   |                |
 |   (limited service)    |                   |                |
 *<=================*     |                   |                |
(MMI 1)                   |                   |                |
 |                       |                   |                |
a) further PLMNs available
 |                       |                   |                |
 |                       |           RR ACTIVATE REQ          |
 |                      *===============================>*
 |                       |                   |              (RR 1)
 |                       |                   |                |
```

(MM 1)
The negative end of cell selection / location updating attempt is recognized by MM.
(MMI 1)
The network search fails. Limited Service is indicated to MMI.
(RR 1)
There has been a list of available PLMNs delivered to MM by RR_ABORT_IND. MM has stored this list for its own internal operation after removing the forbidden PLMNs. If there is an appropriate PLMN available, it selects a different network from this list for another attempt.

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4.7 Negative End, PLMN list not available
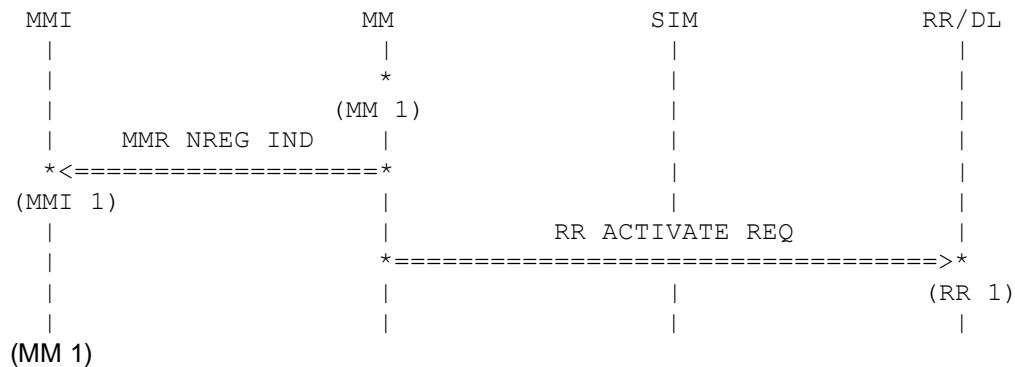
```
MMI                     MM                  SIM                 RR/DL
 |                       |                   |                   |
 |                       *                   |                   |
 |                     (MM 1)                |                   |
 |     MMR NREG IND       |                   |                   |
 *<==================*                   |                   |
(MMI 1)                  |                   |                   |
 |                       |         RR ACTIVATE REQ              |
 |                       *=================================>*
 |                       |                   |             (RR 1)
 |                       |                   |                   |
```
(MM 1)
The negative end of cell selection / location updating attempt is recognized by MM.
(MMI 1)
The network search fails and no network list is available. The cause is forwarded to MMI.
(RR 1)
MM starts a net search for the available networks.

4.8 Change of PLMN Mode

```
MMI                     MM                  SIM                 RR/DL
 |                       |                   |                   |
 |  MMR PLMN MODE REQ    |                   |                   |
 *==================>*                   |                   |
 |                    (MM 1)                |                   |
 |                       |                   |                   |
```
(MM 1)
It is possible to change between automatic and manual mode by the user. This leads to different be-
haviour during registration.

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4.9 Deactivation of MS

```
MMI                        MM                    SIM                  RR/DL
 |                         |                      |                    |
 |     MMR NREG REQ        |                      |                    |
 *====================>*                          |                    |
 |                      (MM 1)                     |                    |
 |                         |                      |                    |
a) No SIM inserted or limited service
 |                         |                      |                    |
 |                         |           RR_DEACTIVATE_REQ              |
 |                      *====================================>*
 |     MMR NREG CNF        |                      |                    |
 *<==================*                            |                    |
(MMI 1)                    |                      |                    |
 |                         |                      |                    |
b) SIM inserted
 |                         |                      |                    |
 |                      *<IMSI Detach ...>                             |
 |                      (MM 2)                     |                    |
 |                         |           RR_DEACTIVATE_REQ              |
 |                      *====================================>*
 |     MMR NREG CNF        |                      |                    |
 *<==================*                            |                    |
(MMI 2)                    |                      |                    |
 |                         |                      |                    |
```
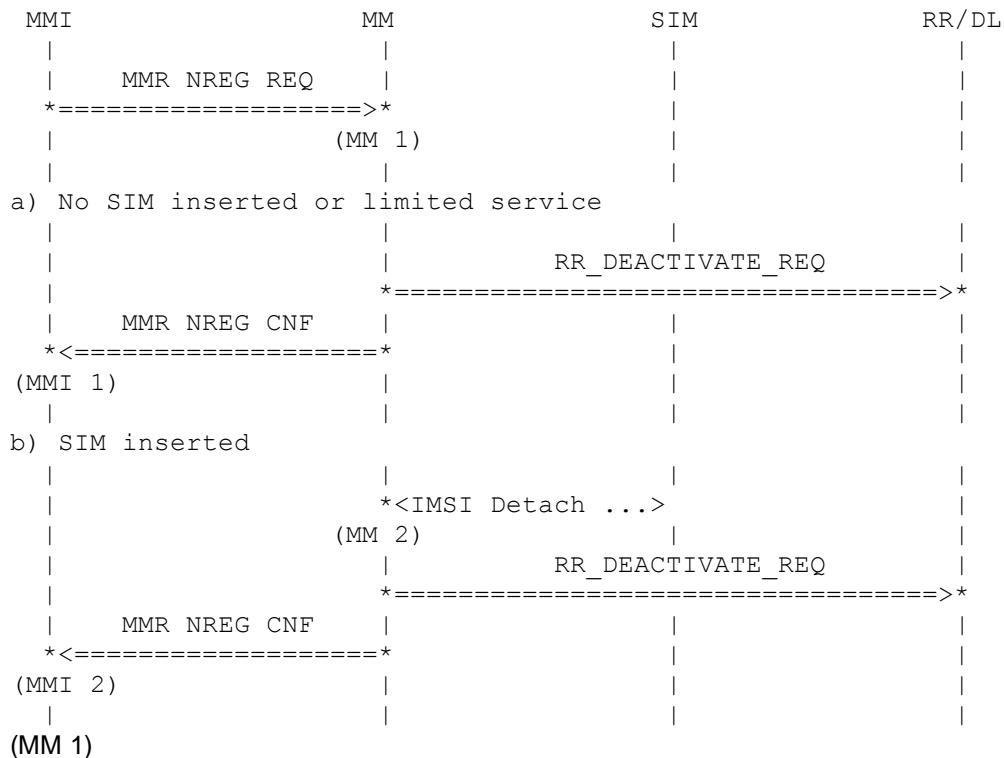
(MM 1)

If the mobile station is switched off, MMI informs MM by MMR NREG REQ, parameter
CS_POW_OFF.

(MMI 1)

If no SIM is inserted or the mobile station has only limited service, a confirmation is send to MMI and
no further procedures are processed. RR is informed about the deactivation.

(MM 2)

If indicated by the network and a SIM is inserted, MM starts the IMSI detach procedure.

(MMI 2)

The confirmation is send to MMI after RR has been deactivated.

4.10 SIM Remove

```
MMI                     MM                  SIM                 RR/DL
 |                       |                   |                   |
 |                       |   SIM REMOVE IND  |                   |
 |                      *<================*                      |
 |                    (MM 1)               |                   |
 |                       *<IMSI Detach ...>                     |
 |                    (MM 2)               |                   |
 |      MMR NREG IND      |                 |                   |
 *<==================*                      |                   |
(MMI 1)                   |                 |                   |
 |                       |                   |                   |
```
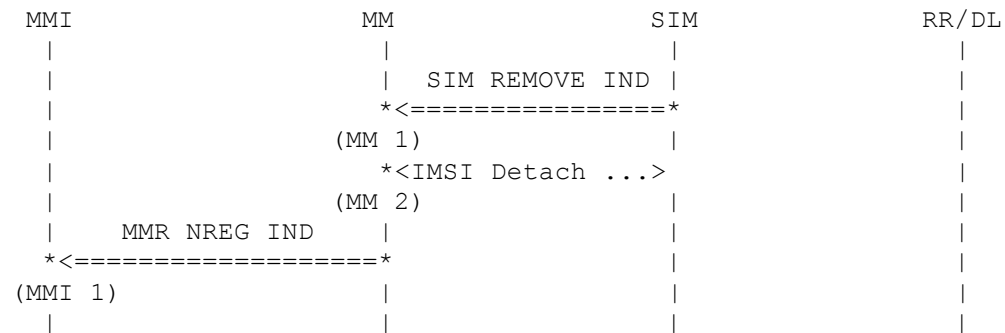
(MM 1)
The SIM application has recognized a SIM remove.
(MM 2)
If MM is in IDLE, NORMAL SERVICE state and it is indicated by the network on the BCCH the IMSI
Detach procedure is started.
(MMI 1)
An indication about the SIM remove is sent to MMI.

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4.11 Net Request (Automatic Mode)

```
 MMI                     MM                      SIM             RR/DL
  |                       |                       |               |
  |     MMR NET REQ       |                       |               |
  *==================>*                           |               |
  |                       |                       |               |
  |                    (MM 1)                      |               |
  |                       |       RR ACTIVATE REQ                  |
  |                       *================================>*
  |                       |                       |            (RR 1)
  |                       |         RR ABORT IND                   |
  |                       *<================================*
  |                    (MM 2)                      |               |
  |     MMR PLMN IND      |                       |               |
  *<==================*                            |               |
(MMI 1)                   |                       |               |
  |                       |                       |               |
```
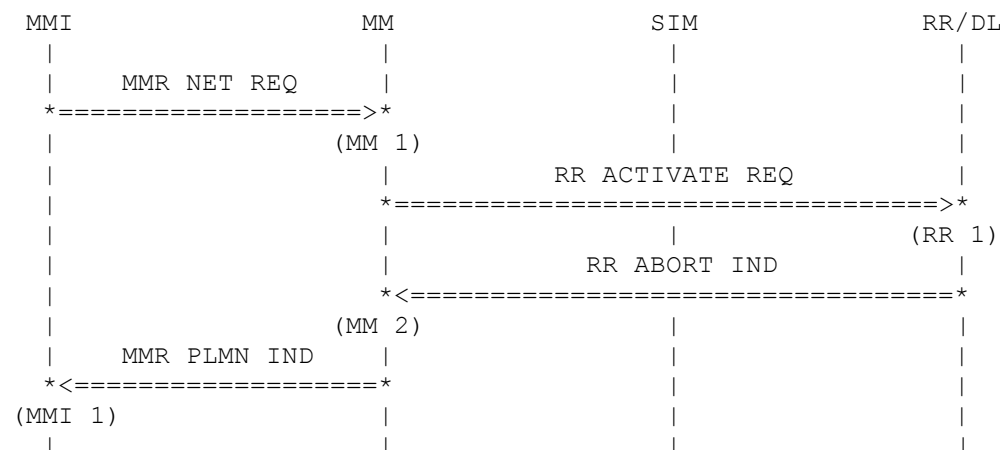
(MM 1)
MMI starts a net request in automatic mode.
(RR 1)
The net request is forwarded to RR. A net request for RR is a cell selection to a non-existing network identification. This search is done without disturbing the actual selected network in RR.
(MM 2)
This leads to a negative end of cell selection with the cause cell selection failed. As a result of this a network list is prepared by RR and given to MM.
(MMI 1)
The network list is forwarded to MMI.

4.12 Net Request (Manual Mode)

```
 MMI                     MM                      SIM             RR/DL
  |                       |                       |               |
  |     MMR NET REQ       |                       |               |
  *==================>*                           |               |
  |                       |                       |               |
  |                    (MM 1)                      |               |
  |                       |       RR ACTIVATE REQ                  |
  |                       *================================>*
  |                       |                       |            (RR 1)
  |                       |         RR ABORT IND                   |
  |                       *<================================*
  |                    (MM 2)                      |               |
  |                       |                       |               |
a) PLMNs available
  |                       |                       |               |
  |     MMR PLMN IND      |                       |               |
  *<==================*                            |               |
(MMI 1)                   |                       |               |
  |     MMR PLMN RES      |                       |               |
  *==================>*                            |               |
  |                    (MM 3)                      |               |
  |                       |       RR ACTIVATE REQ                  |
  |                       *================================>*
  |                       |                       |            (RR 2)
  |                       |                       |               |
b) no PLMN available
  |                       |                       |               |
  |     MMR NREG IND      |                       |               |
  *<==================*                            |               |
```
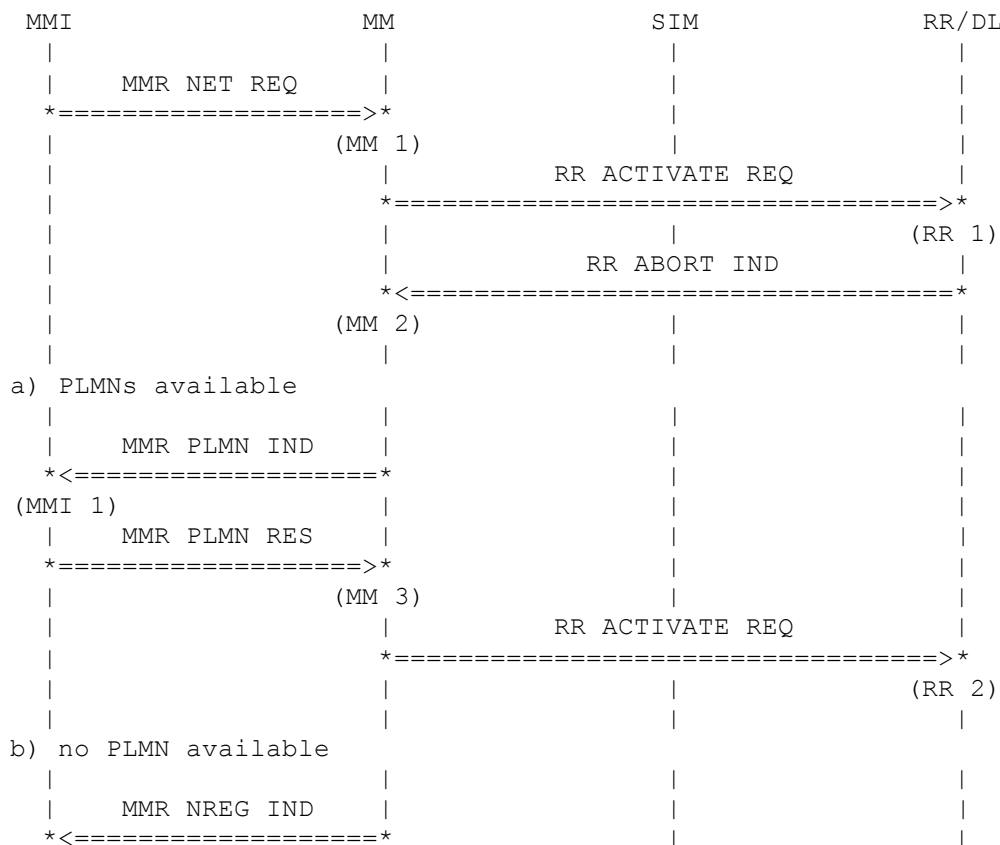
```
(MMI 2)                     |                   |                   |
   |                        |                   |                   |
```
(MM 1)

The net request in manual mode means first detecting all available networks and then selecting one of the networks.

(RR 1)

The net request is forwarded to RR. Net request for RR is a cell selection to a non-existing network identification.

(MM 2)

This leads to a failed cell selection with the cause cell selection failed. As a result of this RR has collected all available network identifications.

(MMI 1)

If networks are available the list is forwarded to MMI for selection.

(MM 3)

The user has selected one of the networks.

(RR 2)

The cell selection to this network is restarted.

(MMI 2)

If no network is available, a negative registration indication is send to MMI.

4.13 Net Request (Abnormal Cases)

```
MMI                     MM                  SIM              RR/DL
 |                       |                   |                   |
 |     MMR NET REQ       |                   |                   |
 *==================>*                       |                   |
 |                    (MM 1)                  |                   |
 |     MMR PLMN IND      |                   |                   |
 *<==================*                       |                   |
(MMI 1)                  |                   |                   |
 |                       |                   |                   |
```
(MM 1)

The user starts a net request during dedicated mode, during a running net request or if no SIM is inserted.

(MMI 1)

The request is rejected and the appropriate cause is send back to MMI.

5 Normal Location Updating-

5.1 Initiation

```
MMI                     MM                  SIM              RR/DL
 |                      |                    |                |
 |                      |           RR ESTABLISH REQ          |
 |                      |         (Location Updating Request) |
 |                      *================================>*
 |                      |                    |               (RR 1)
 |                      |                    |                |
```
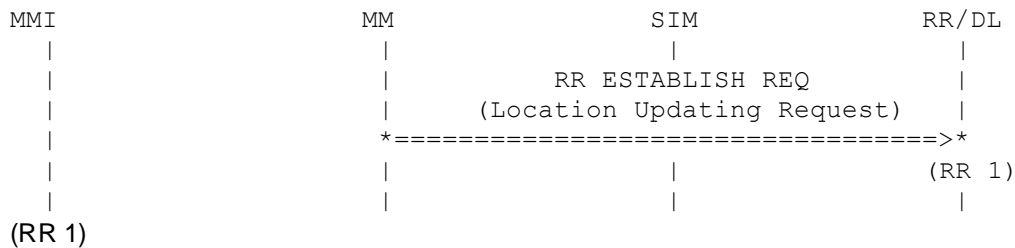
(RR 1)
After selecting a cell of a different location area, MM starts a location updating. Therefore the estab-
lishment of the RR-connection is requested. The inital message is the location updating request
messsage.
If no Test SIM card is inserted the location updating is started also all six minutes or after a
fieldstrength jump of more than 10 dBm for the actual serving cell, if the mobile is in the state IDLE
ATTEMPT TO UPDATE. This mechanism is not defined in GSM, but it shall increase the availability of
the mobile.

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5.2 Location Updating Accept

```
MMI                     MM                  SIM              RR/DL
 |                       |                   |                |
 |                       |          RR ESTABLISH CNF          |
 |                      *<===============================*    |
 |                     (MM 1)              |                |
 |                       |          RR DATA IND             |
 |                       |      (LOCATION UPDATE ACCEPT)     |
 |                      *<===============================*    |
 |                     (MM 2)              |                |
 |                       |                   |                |
a) Mobile Identity Type is TMSI            |                |
 |                       |                   |                |
 |                       |          RR DATA REQ             |
 |                       |    (TMSI REALLOCATION COMPLETE)   |
 |                      *===============================>*    |
 |                       |                   |         (RR 1)
 |                       |          RR SYNC REQ             |
 |                       |              (tmsi)              |
 |                      *===============================>*    |
 |                       |                   |         (RR 2)
 |                       |          RR SYNC REQ             |
 |                       |          (LAI allowed)           |
 |                      *===============================>*    |
 |                       |                   |         (RR 3)
 |                       |                   |                |
b) Mobile Identity Type is IMSI            |                |
 |                       |                   |                |
 |                       |          RR SYNC REQ             |
 |                       |           (clear tmsi)           |
 |                      *===============================>*    |
 |                       |                   |         (RR 4)
 |                       |          RR SYNC REQ             |
 |                       |          (LAI allowed)           |
 |                      *===============================>*    |
 |                       |                   |         (RR 3)
 |                       |                   |                |
c) Mobile Identity Type is IMEI            |                |
 |                       |                   |                |
 |                       |          RR DATA REQ             |
 |                       |           (MM STATUS)            |
 |                      *===============================>*    |
 |                       |                   |         (RR 5)
 |                       |                   |                |
d) Mobile Identity is empty                |                |
 |                       |                   |                |
 |                       |          RR SYNC REQ             |
 |                       |          (LAI allowed)           |
 |                      *===============================>*    |
 |                       |                   |         (RR 3)
 |                       |                   |                |
 |     MMR REG CNF       |                   |                |
 *<==================*   |                   |                |
 (MMI 1)                 |                   |                |
 |                       |SIM MM UPDATE REQ|                |
 |                      *===============>*                  |
 |                       |          (SIM 1)                  |
 |                       |                   |                |
```

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(MM 1)
Establishment of the RR-connection is successfull.
(MM 2)
The infrastructure answers with a location updating accept message. This means the location updating was successfull. The message may contain a mobile identity.
(RR 1)
If the mobile identity type is a TMSI, an implicit TMSI reallocation has occured. MM stores the new TMSI and sends a TMSI Reallocation Complete message to the infrastructure.
(RR 2)
The new TMSI is forwarded to RR for later paging by this TMSI.
(RR 3)
It is signalled to RR that the location area is allowed. If this location area is stored in the forbidden location area list of RR, it is removed from this list.
(RR 4)
If the mobile identity type of the location updating accept message is an IMSI, MM deletes a stored TMSI. RR is informed that a stored TMSI is not longer valid.
(RR 5)
If the mobile identity type of the location updating accept message is an IMEI, MM creates a Status message and sends it back to the infrastructure. The mobile identity is ignored.
(MMI 1)
MMI is informed about the successfull location updating.
(SIM 1)
The changed location parameter are forwarded to the SIM application.

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5.3 Location Updating Reject

```
MMI                      MM                  SIM               RR/DL
 |                        |                   |                  |
 |                        |           RR ESTABLISH CNF          |
 |                        *<================================*
 |                     (MM 1)                 |                  |
 |                        |              RR DATA IND            |
 |                        |         (LOCATION UPDATE REJECT)    |
 |                        *<================================*
 |                     (MM 2)                 |                  |
 |                        |                   |                  |
a) normal release of RR connection
 |                        |                   |                  |
 |                        |            RR RELEASE IND           |
 |                        *<================================*
 |                     (MM 3)                 |                  |
 |                        |                   |                  |
b) abnormal release of RR connection
 |                        |                   |                  |
 |                        |             RR ABORT IND            |
 |                        *<================================*
 |                     (MM 4)                 |                  |
 |                        |                   |                  |
c) Timeout T3240
 |                        |                   |                  |
 |                    *<Timeout T3240>  |                  |
 |                     (MM 5)                 |                  |
 |                        |              RR ABORT REQ           |
 |                        *================================>*
 |                        |                   |            (RR 1)
 |                        |                   |                  |
 |                        |             MDL RELEASE REQ         |
 |                        *================================>*
 |                        |                   |            (RR 2)
 |                        |                   |                  |
```
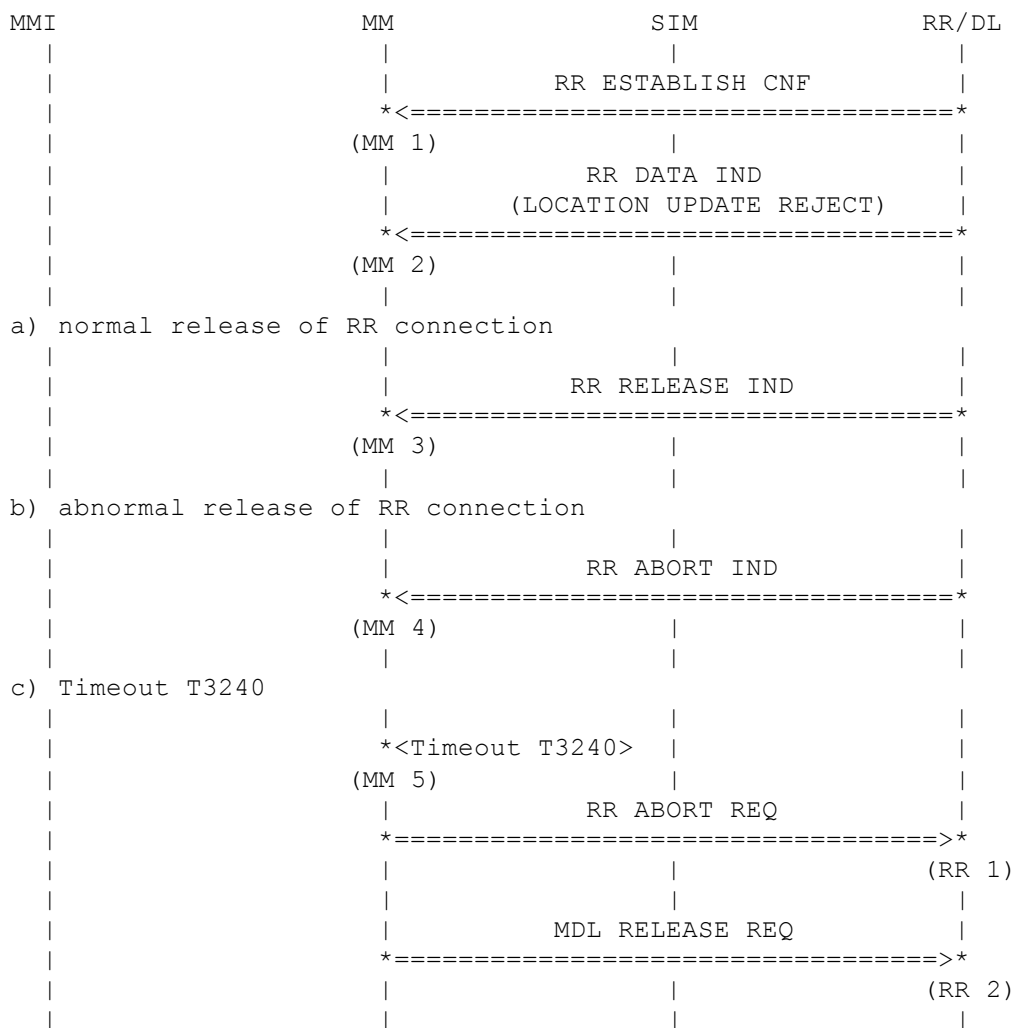
(MM 1)
The RR connection is established.
(MM 2)
The infrastructure rejects the location updating. The reject cause is stored by MM until release of the RR connection.
(MM 3)
The connection is released by RR without reception of an answer of the infrastructure.
(MM 4)
The RR connection is aborted by RR. Possible causes are radio link failure or low level data link failure.
(MM 5)
There is no response from the infrastructure and the timer T3240 of MM times-out.
(RR 1)
The RR connection is aborted by MM.
(RR 2)
Data Link Layer is resetted by MM.

5.3.1 Authentication Failure occured

It is assumed that a dedicated connection to the network exists, e.g. during the location update procedure in state LOCATION UPDATING INITIATED. SIM data is present in MM and considered as valid.

```
MMI                      MM                  SIM               RR/DL
 |                        |                   |                  |
```

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```
|                        |                    RR_DATA_IND                 |
|                        |               (AUTHENTICATION REQUEST)         |
|                        *<=======================================*
|       (MM 1)           |                    |                  |
|                        | SIM_AUTHENTICATION_REQ |              |
|                        *=======================>*              |
|                        |                    |                  |
|                        | SIM_AUTHENTICATION_CNF |              |
|                        *<=======================*              |
|       (MM 2)           |                    |                  |
|                        |                    RR_DATA_REQ                 |
|                        |               (AUTHENTICATION RESPONSE)        |
|                        *=======================================>*
|                        |                    RR_SYNC_REQ                 |
|                        |                    (CKSN, KC)                  |
|                        *=======================================>*
|                        |                    RR_DATA_IND                 |
|                        |               (AUTHENTICATION FAILURE)         |
|                        *<=======================================*
|       (MM 3)           |                    |                  |
|                        |                    RR SYNC REQ                 |
|                        |               (auth failure no paging)         |
|                        *=======================================>*
|                        |  SIM MM UPDATE REQ     |              |
|                        *=======================>*              |
|                        |                    |                  |
|                        |                    RR_RELEASE_IND              |
|                        *<=======================================*
|       (MM 4)           |                    |                  |
|                        |                    MDL_RELEASE_REQ             |
|                        *=======================================>*
|      MMR NREG IND       |                    |                  |
|     (limited service)  |                    |                  |
*<=====================*                       |                  |
|                        |                    |                  |
```
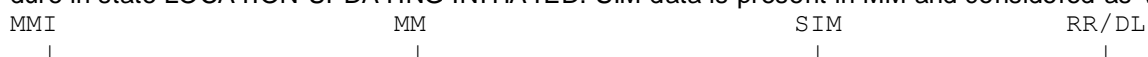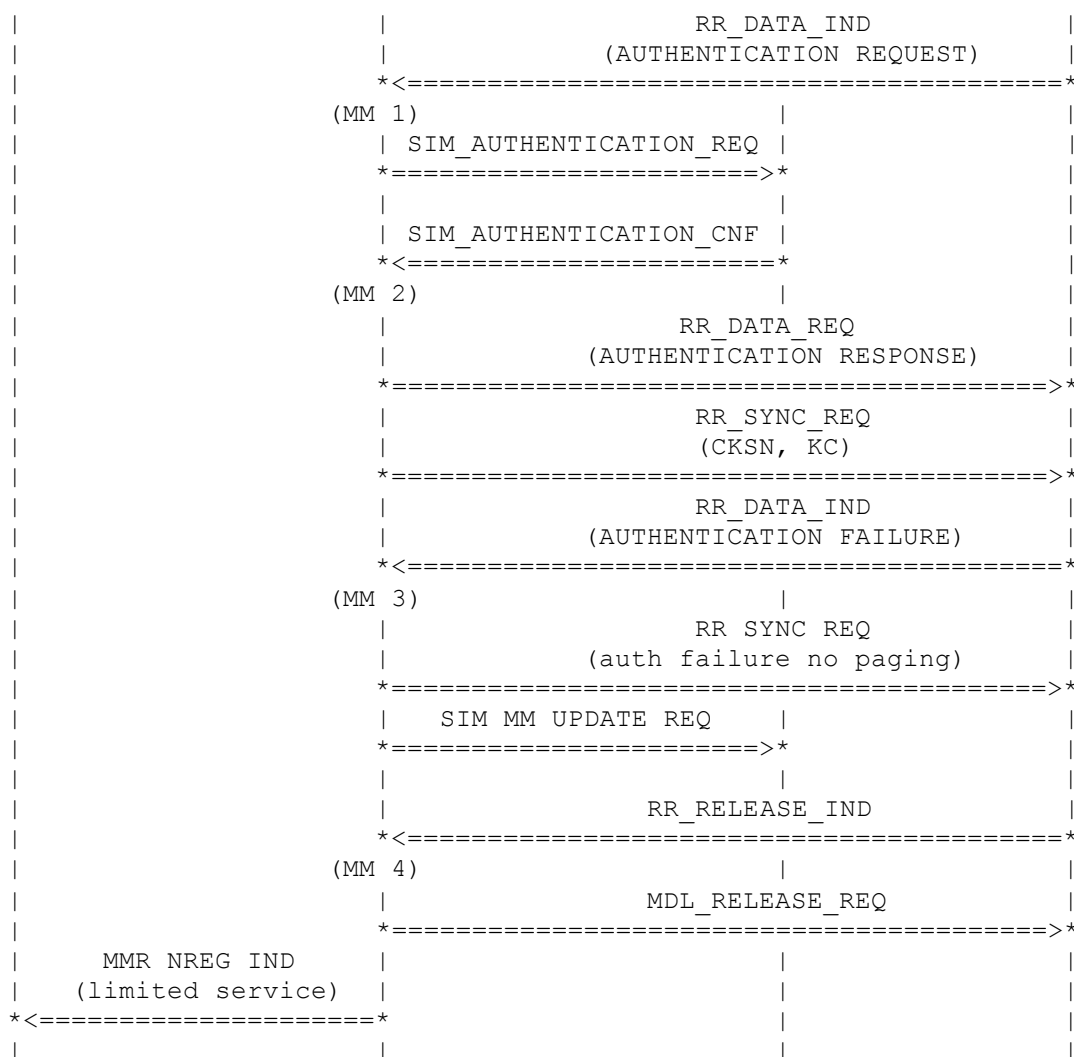
(MM 1)
During e.g. location updating the network performs the authentication procedure. The RAND received from the network is sent to the SIM entity to be processed.

(MM 2)
The SIM processed from the RAND the SRES, the CKSN and KC. These values are sent to MM. MM forwards the SRES to the network in the AUTHENTICATION RESPONSE message. RR is informed about the new CKSN and KC by a synchronization primitive.

(MM 3)
The network compared the received SRES value with the value it processed itself from the RAND. The values didn't match. A AUTHENTICATION FAILURE message was sent by the network and received by MM. The SIM will be considered as invalid until power cycle or equivalent procedure from now on. The lower layers will not answer to paging anymore.

(MM 4)
After the release of the RR connection, the layer 2 is reset by MM and the MMI is informed about the limited service condition.

5.3.2 Reject Cause #11 (PLMN not allowed)

```
MMI                     MM                  SIM                 RR/DL
 |                       |                    |                  |
 |                       |                 RR SYNC REQ           |
 |                       |          (delete registration data)  |
 |                       *=================================>*
 |                       |                 RR SYNC REQ           |
 |                       |          (delete requested network)  |
```

```
   |                        *===================================>*
   |               |                 |                    (RR 1)
   |               |SIM MM UPDATE REQ|                        |
   |               *===============>*                         |
   |               |              (SIM 1)                     |
   |    MMR NREG IND     |                 |                   |
  *<==================*                 |                   |
(MMI 1)              |                 |                   |
   |               |                 |                   |
```

(RR 1)
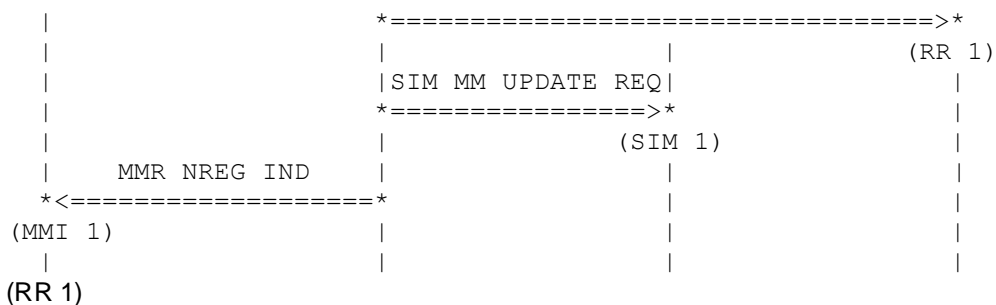
During location updating the reject cause #11 PLMN not allowed was signalled to MM with a location updating reject message. RR is informed by sending a RR_SYNC_REQ that it has to delete the registration data, which are the TMSI, the CKSN and Kc. Also RR is informed that it has to delete the currently by MM requested network. In case there is no MM internal list of available networks from which an alternative network can be requested by MM, this will lead to a full network search which ends with an RR_ABORT_IND containing an updated list of available networks.

(SIM 1)

The location parameters on the SIM card are removed.

(MMI 1)

The user is informed about the negative location updating.

5.3.3 Reject Cause #12 (Location Area not allowed)

```
MMI                        MM                   SIM                 RR/DL
 |                          |                    |                    |
 |                          |              RR SYNC REQ                |
 |                          |             (LA not allowed)            |
 |                          *=================================>*
 |                          |                    |              (RR 1)
 |                          |SIM MM UPDATE REQ|                    |
 |                          *===============>*                     |
 |                          |              (SIM 1)                  |
 |       MMR NREG IND        |                    |                    |
   *<==================*                          |                    |
(MMI 1)                     |                    |                    |
 |                          |                    |                    |
```
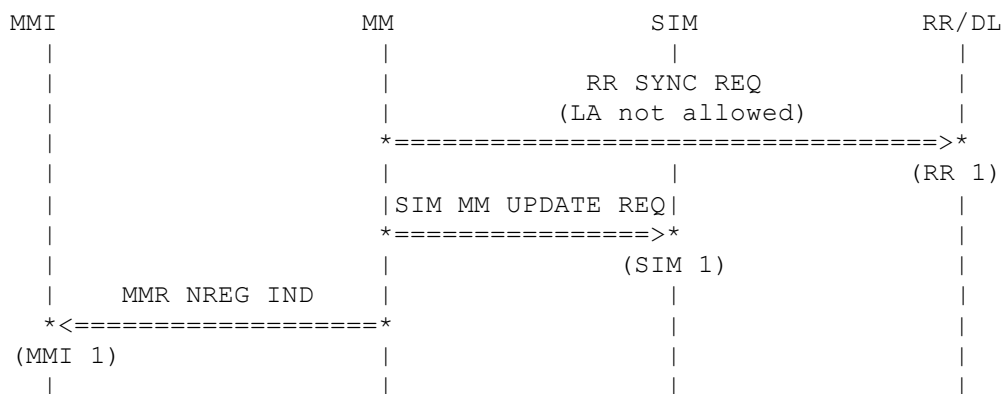
(RR 1)
During location updating the reject cause #12 Location Area not allowed was signalled to MM with a location updating reject message. RR is informed with the cause location area not allowed. It adds the location area to the forbidden location area list.
(SIM 1)
The location parameters on the SIM card are updated.
(MMI 1)
The user is informed about the rejected location updating.

5.3.4 Reject Cause #13 (Roaming not allowed)

```
MMI                        MM                   SIM                 RR/DL
 |                          |                    |                    |
 |                          |              RR SYNC REQ                |
 |                          |    (LA not allowed for roaming)         |
 |                          *=================================>*
 |                          |                    |              (RR 1)
 |                          |SIM MM UPDATE REQ|                    |
 |                          *===============>*                     |
 |                          |              (SIM 1)                  |
 |       MMR NREG IND        |                    |                    |
   *<==================*                          |                    |
(MMI 1)                     |                    |                    |
 |                          |                    |                    |
```
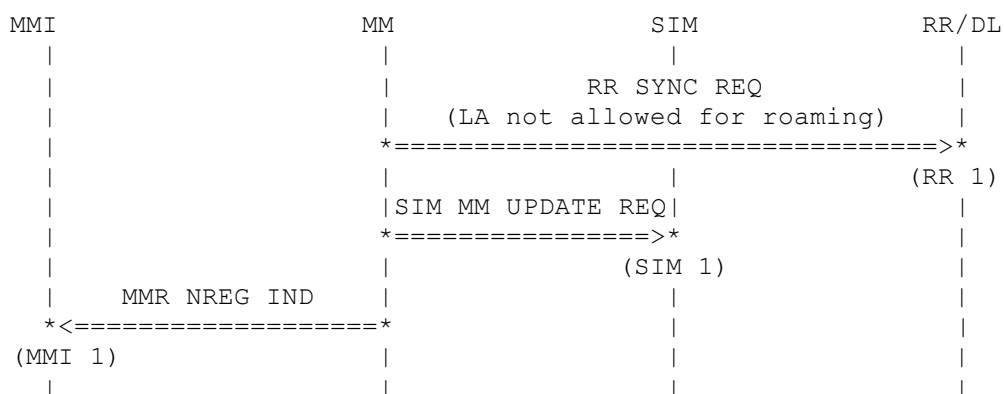
(RR 1)
During location updating the reject cause #13 National Roaming not allowed in this area was signalled to MM with a location updating reject message. RR is informed with the cause location area not allowed for roaming. It stores the loaction area identification in the forbidden location area for roaming list.
(SIM 1)
The location parameters on the SIM card are updated.
(MMI 1)
The user is informed about the rejected location updating.

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5.3.5 Reject Cause #2, #3, #6 (invalid IMSI or card)

```
MMI                      MM                  SIM              RR/DL
 |                       |                    |                |
 |                       |            RR SYNC REQ              |
 |                       |         (Auth Fail no paging)       |
 |                       *===============================>*
 |                       |                    |            (RR 1)
 |                       |SIM MM UPDATE REQ|                   |
 |                       *===============>*                    |
 |                       |              (SIM 1)                |
 |      MMR NREG IND      |                    |                |
 *<==================*                     |                |
(MMI 1)                  |                    |                |
 |                       |                    |                |
```
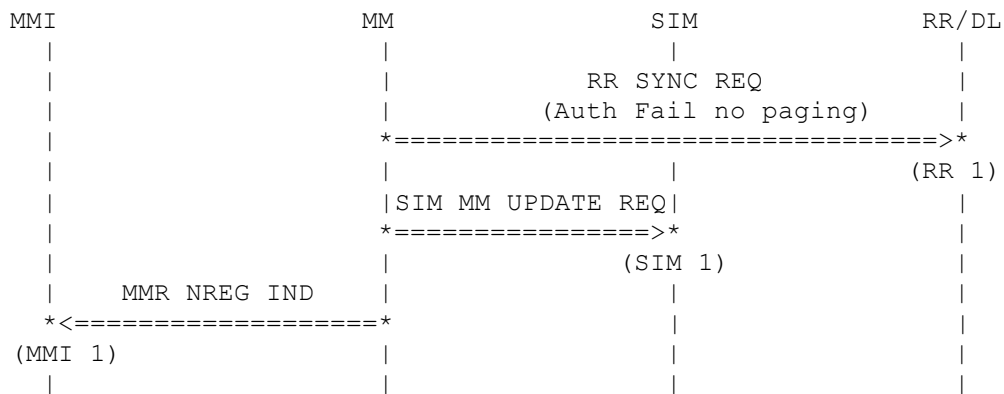
(RR 1)
During location updating the reject cause #2 IMSI unknown in HLR, #3 illegal MS or #6 ilegal ME was signalled to MM with a location updating reject message. RR is informed with the cause auth failure no paging. It deletes the IMSI, TMSI, CKSN and Kc.
(SIM 1)
The location parameters on the SIM card are removed.
(MMI 1)
The user is informed about the rejected location updating with the cause Illegal ME.

5.4 Location Updating Restart

```
MMI                      MM                  SIM              RR/DL
 |                       |                    |                |
a) access counter < 4 and SIM-LAI equal current LAI and MS is updated
 |                       |                    |                |
 |                      *<start T3211>        |                |
 |                     (MM 1)                 |                |
 |                       |                    |                |
b) access counter < 4
 |                       |                    |                |
 |                       |            RR SYNC REQ              |
 |                       |             (Auth Fail)             |
 |                      *================================>*    |
 |                       |                    |           (RR 1)
 |                      |SIM MM UPDATE REQ|                    |
 |                      *===============>*                     |
 |                       |              (SIM 1)                 |
 |                      *<start T3211>        |                |
 |                     (MM 1)                 |                |
 |                       |                    |                |
c) access counter >= 4
 |                       |                    |                |
 |                       |            RR SYNC REQ              |
 |                       |             (Auth Fail)             |
 |                      *================================>*    |
 |                       |                    |           (RR 1)
 |                      |SIM MM UPDATE REQ|                    |
 |                      *===============>*                     |
 |                       |              (SIM 1)                 |
 |    MMR NREG IND       |                    |                |
 *<==================*                        |                |
(MMI 1)                  |                    |                |
 |                       |                    |                |
```
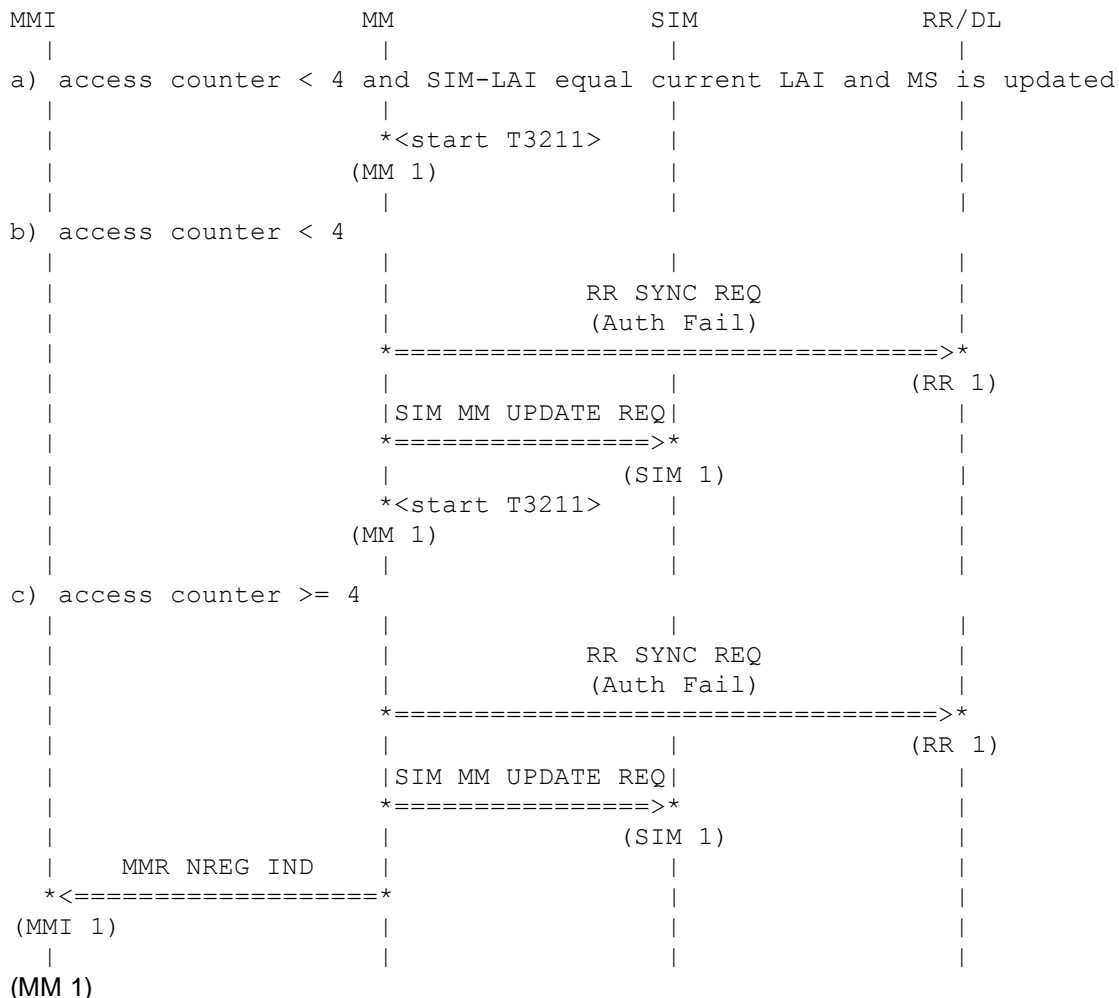
(MM 1)
If the location updating access counter is less than four, the MS is in the same location area and up-dated only the timer T3211 is started.
After timeout of T3211 the next attempt is started.
(RR 1)
If the MS is not updated but the access counter is less than four, RR is informed with the cause Authentication Failure. RR removes the TMSI, CKSN and Kc if available.
(SIM 1)
The location parameter of the SIM card are updated.
(MMI 1)
If more than four attempts have failed the user is informed about the new service mode.

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6 Periodic Location Updating

```
MMI                       MM                SIM            RR/DL
 |                        |                 |              |
 |                    *<timeout T3212>      |              |
 |                    (MM 1)                |              |
 |                        |                 |              |
a) Periodic Location Updating not allowed
 |                        |                 |              |
 |                        |                 |              |
b) Periodic Location Updating allowed
 |                        |                 |              |
 |                        |       RR ESTABLISH REQ         |
 |                        |    (Periodic Location Updating) |
 |                    *==================================>*
 |                        |                 |          (RR 1)
 |                        |                 |              |
```
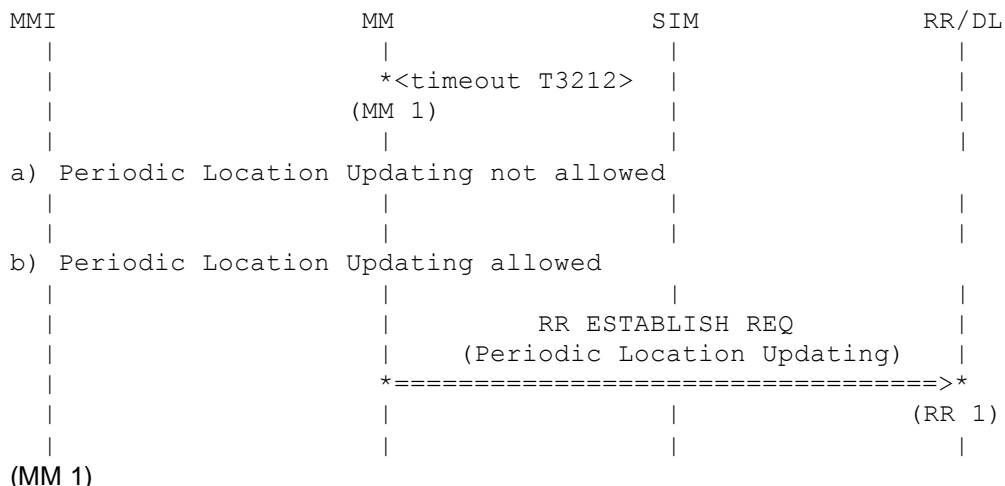
(MM 1)
If indicated by the network a periodic location updating is processed in regular times. Therefore a timer T3212 is starting during entering the idle mode. If this timer times-out the periodic location updating is started. If at time-out the periodic location updating is not indicated by the network or the MM is not in idle mode the time-out is ignored.

(RR 1)
Else establishment of the RR connection is started. The initial message is the location updating request message. The procedure itself is equal to normal location updating.

7 IMSI Attach

```
MMI                       MM                SIM            RR/DL
 |                        |                 |              |
 |                        *                 |              |
 |                    (MM 1)                |              |
 |                        |       RR ESTABLISH REQ         |
 |                        |        (IMSI Attach)           |
 |                    *==================================>*
 |                        |                 |          (RR 1)
 |                    *...Location Updating Procedure
 |                        |                 |              |
```
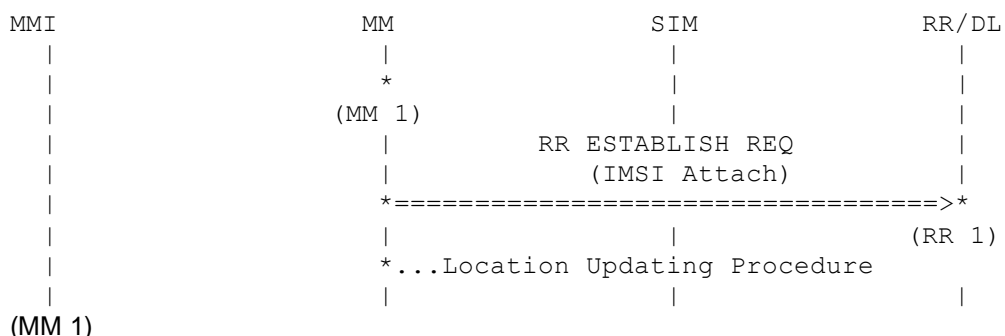
(MM 1)
The network may indicate IMSI attach. That means that after SIM insertion a location updating procedure is forced.

(RR 1)
Establishment of the RR connection is started. The initial message is the location updating request message. The procedure itself is equal to normal location updating, only in the LOCATION UPDATING REQUEST message sent to the network the location update type is different.

TEXAS INSTRUMENTS

8 IMSI Detach

There are some possible causes for IMSI DETACH
1.) IMSI DETACH after power off
2.) IMSI DETACH after SIM manager detected physical SIM remove
3.) IMSI DETACH after MMI requested logical SIM remove

8.1 IMSI Detach after MMI request to power off the phone
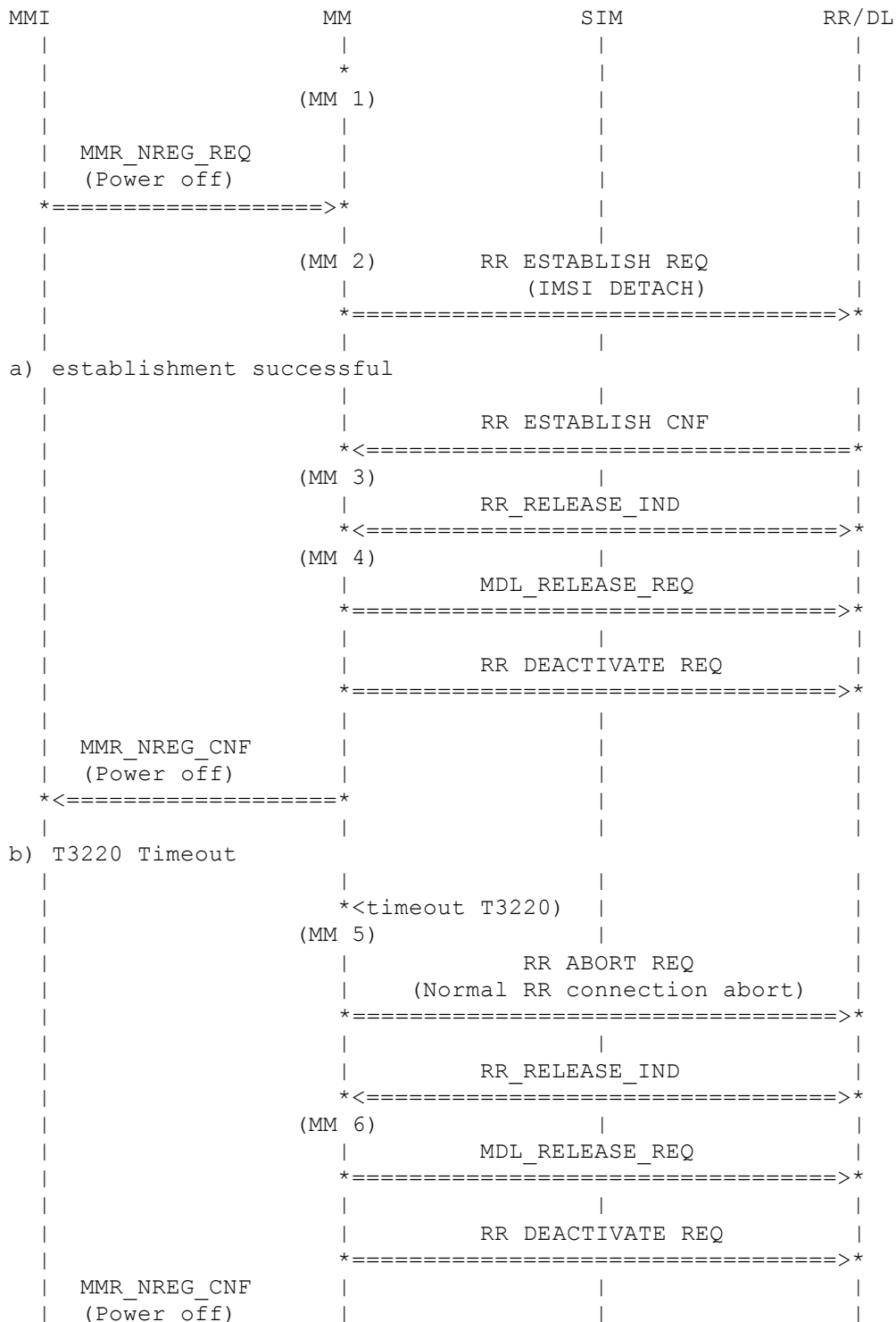
```
MMI                      MM                  SIM              RR/DL
 |                        |                   |                |
 |                        *                   |                |
 |                      (MM 1)                 |                |
 |                        |                   |                |
 |  MMR_NREG_REQ          |                   |                |
 |  (Power off)           |                   |                |
  *==================>*                       |                |
 |                        |                   |                |
 |                      (MM 2)     RR ESTABLISH REQ            |
 |                        |           (IMSI DETACH)            |
 |                        *===================================>*
 |                        |                   |                |
a) establishment successful
 |                        |                   |                |
 |                        |        RR ESTABLISH CNF            |
 |                        *<===================================*
 |                      (MM 3)                 |                |
 |                        |        RR_RELEASE_IND              |
 |                        *<==================================>*
 |                      (MM 4)                 |                |
 |                        |        MDL_RELEASE_REQ             |
 |                        *==================================>*
 |                        |                   |                |
 |                        |        RR DEACTIVATE REQ           |
 |                        *==================================>*
 |                        |                   |                |
 |  MMR_NREG_CNF          |                   |                |
 |  (Power off)           |                   |                |
  *<=================*                         |                |
 |                        |                   |                |
b) T3220 Timeout
 |                        |                   |                |
 |                        *<timeout T3220)    |                |
 |                      (MM 5)                 |                |
 |                        |        RR ABORT REQ                |
 |                        |    (Normal RR connection abort)    |
 |                        *==================================>*
 |                        |                   |                |
 |                        |        RR_RELEASE_IND              |
 |                        *<==================================>*
 |                      (MM 6)                 |                |
 |                        |        MDL_RELEASE_REQ             |
 |                        *==================================>*
 |                        |                   |                |
 |                        |        RR DEACTIVATE REQ           |
 |                        *==================================>*
 |  MMR_NREG_CNF          |                   |                |
 |  (Power off)           |                   |                |
```

```
     *<===================*                 |                       |
     |                    |                 |                       |
```
(MM 1)

The network may indicate IMSI detach. That means that the mobile station signals its de-registration at power off or SIM remove to the network. MM is in IDLE, NORMAL SERVICE state.

(MM 2)

Swich off is requested by the MMI. As the network requires IMSI ATTACH/DETACH, for deregistration a RR connection. The initial message is the IMSI Detach message.

(MM 3)

RR signals the successfull establishment of the RR connection. The IMSI DETACH message has been received by the network.

(MM 4)

After RR indicated the release of the layer 2 connection, layer 2 is reset by MM and the lower layers are deactivated. As last action the deactivation is confirmed to the MMI.

(MM 5)

After the establishment of the RR connection has requested by MM, before the release of the RR connection was indicated by RR, the timer T3220 timed out. RR requests the abortion of the requested or established RR connection. In this situation RR guarantees a RR_RELEASE_IND after the layer 2 connection has been finally released.

(MM 6)

RR indicates that the layer 2 connection has been released after the request to abort the RR connection. Layer 2 is reset, the lower layers are deactivated and the deregistraton request is confirmed to the MMI.

8.2 IMSI detach after SIM manager detected physical removal of SIM
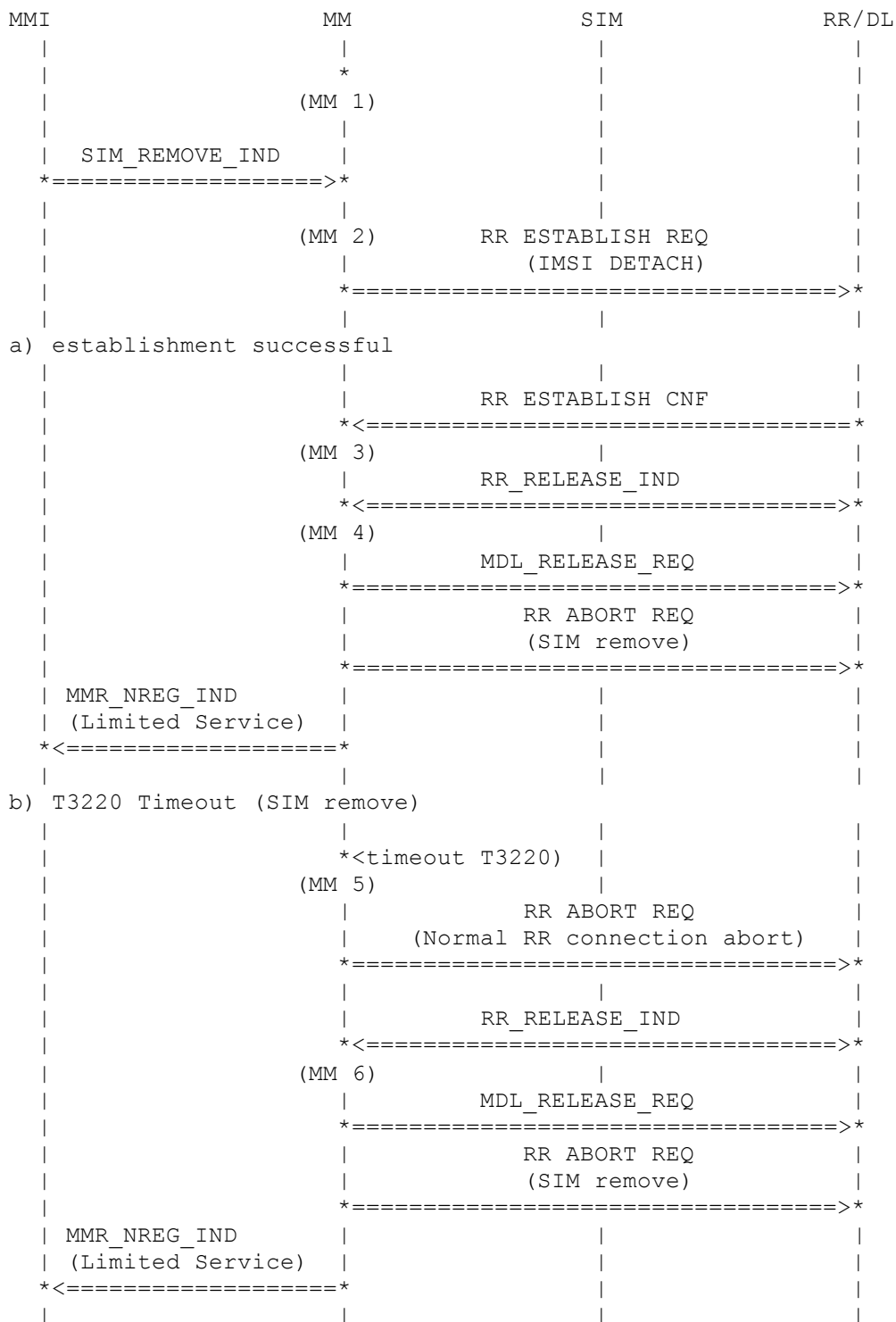
```
MMI                     MM                  SIM                RR/DL
 |                       |                   |                   |
 |                       *                   |                   |
 |                     (MM 1)                |                   |
 |                       |                   |                   |
 |   SIM_REMOVE_IND      |                   |                   |
 *==================>*   |                   |                   |
 |                       |                   |                   |
 |                     (MM 2)    RR ESTABLISH REQ                |
 |                       |          (IMSI DETACH)                |
 |                       *===============================>*      |
 |                       |                   |                   |
a) establishment successful                 |                   |
 |                       |                   |                   |
 |                       |     RR ESTABLISH CNF               |
 |                       *<===============================*      |
 |                     (MM 3)                |                   |
 |                       |     RR_RELEASE_IND                 |
 |                       *<===============================>*     |
 |                     (MM 4)                |                   |
 |                       |     MDL_RELEASE_REQ               |
 |                       *===============================>*      |
 |                       |        RR ABORT REQ               |
 |                       |         (SIM remove)              |
 |                       *===============================>*      |
 |   MMR_NREG_IND        |                   |                   |
 |  (Limited Service)    |                   |                   |
 *<==================*   |                   |                   |
 |                       |                   |                   |
b) T3220 Timeout (SIM remove)               |                   |
 |                       |                   |                   |
 |                       *<timeout T3220)    |                   |
 |                     (MM 5)                |                   |
 |                       |        RR ABORT REQ               |
 |                       |   (Normal RR connection abort)    |
 |                       *===============================>*      |
 |                       |                   |                   |
 |                       |      RR_RELEASE_IND                |
 |                       *<===============================>*     |
 |                     (MM 6)                |                   |
 |                       |      MDL_RELEASE_REQ              |
 |                       *===============================>*      |
 |                       |        RR ABORT REQ               |
 |                       |         (SIM remove)              |
 |                       *===============================>*      |
 |   MMR_NREG_IND        |                   |                   |
 |  (Limited Service)    |                   |                   |
 *<==================*   |                   |                   |
 |                       |                   |                   |
```

(MM 1)
The network may indicate IMSI detach. That means that the mobile station signals its de-registration at power off or SIM remove to the network. MM is in IDLE, NORMAL SERVICE state.
(MM 2)
The SIM manager detects that the SIM has been removed. This is indicated to MM.
(MM 3)

TEXAS INSTRUMENTS

RR signals the successfull establishment of the RR connection. The IMSI DETACH message has been received by the network.
(MM 4)
After RR indicated the release of the layer 2 connection, layer 2 is reset by MM and the lower layers are informed about the SIM removal. As last action the resulting limit service is indicated to the MMI.
(MM 5)
After the establishment of the RR connection has requested by MM, before the release of the RR connection was indicated by RR, the timer T3220 timed out. RR requests the abortion of the requested or established RR connection. In this situation RR guarantees a RR_RELEASE_IND after the layer 2 connection has been finally released.
(MM 6)
RR indicates that the layer 2 connection has been released after the request to abort the RR connection. Layer 2 is reset, the SIM data is invalidated for lower layers and the resulting limit service is indicated to the MMI.

TEXAS INSTRUMENTS

8.3 IMSI detach after the MMI requested logical invalidation of the SIM

```
MMI                      MM                    SIM                   RR/DL
 |                        |                     |                     |
 |                        *                     |                     |
 |                      (MM 1)                   |                     |
 |                        |                     |                     |
 |   MMR_NREG_REQ         |                     |                     |
 |    (SIM remove)        |                     |                     |
 *====================>*                        |                     |
 |                        |                     |                     |
 |                      (MM 2)      RR ESTABLISH REQ                   |
 |                        |           (IMSI DETACH)                   |
 |                        *================================>*          |
 |                        |                     |                     |
a) establishment successful (power off)
 |                        |                     |                     |
 |                        |      RR ESTABLISH CNF                      |
 |                        *<================================*          |
 |                      (MM 3)                   |                     |
 |                        |      RR_RELEASE_IND                        |
 |                        *<================================>*         |
 |                      (MM 4)                   |                     |
 |                        |      MDL_RELEASE_REQ                       |
 |                        *================================>*          |
 |                        |      RR ABORT REQ                          |
 |                        |       (SIM remove)                        |
 |                        *================================>*          |
 |   MMR_NREG_CNF         |                     |                     |
 |    (SIM remove)        |                     |                     |
 *<==================*                           |                     |
 |                        |                     |                     |
b) T3220 Timeout
 |                        |                     |                     |
 |                        *<timeout T3220)      |                     |
 |                      (MM 5)                   |                     |
 |                        |      RR ABORT REQ                          |
 |                        |  (Normal RR connection abort)             |
 |                        *================================>*          |
 |                        |                     |                     |
 |                        |      RR_RELEASE_IND                        |
 |                        *<================================>*         |
 |                      (MM 6)                   |                     |
 |                        |      MDL_RELEASE_REQ                       |
 |                        *================================>*          |
 |                        |      RR ABORT REQ                          |
 |                        |       (SIM remove)                        |
 |                        *================================>*          |
 |   MMR_NREG_CNF         |                     |                     |
 |    (SIM remove)        |                     |                     |
 *<==================*                           |                     |
 |                        |                     |                     |
```

(MM 1)
The network may indicate IMSI detach. That means that the mobile station signals its de-registration at power off or SIM remove to the network. MM is in IDLE, NORMAL SERVICE state.
(MM 2)
The MMI requests that the SIM is considered as invalid in MM.

(MM 3)
RR signals the successfull establishment of the RR connection. The IMSI DETACH message has been received by the network.
(MM 4)
After RR indicated the release of the layer 2 connection, layer 2 is reset by MM and the lower layers are informed about the logical SIM removal. As last action the deregistration is confirmed to the MMI.
(MM 5)
After the establishment of the RR connection has requested by MM, before the release of the RR connection was indicated by RR, the timer T3220 timed out. RR requests the abortion of the requested or established RR connection. In this situation RR guarantees a RR_RELEASE_IND after the layer 2 connection has been finally released.
(MM 6)
RR indicates that the layer 2 connection has been released after the request to abort the RR connection. Layer 2 is reset, the SIM data is invalidated for lower layers and the deregistration is confirmed to the MMI.

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9 TMSI Reallocation

```
MMI                     MM                  SIM              RR/DL
 |                       |                   |                 |
 |                       |        RR DATA(ESTABLISH) IND       |
 |                       |         (TMSI REALLOCATION CMD)     |
 |                       *<===============================*
 |                     (MM 1)                 |                 |
 |                       |           RR DATA REQ              |
 |                       |      (TMSI REALLOCATION COMPL)     |
 |                       *===============================>*
 |                       |                   |            (RR 1)
 |                       |           RR SYNC REQ              |
 |                       *===============================>*
 |                       |                   |            (RR 2)
 |                       |SIM MM UPDATE REQ|                 |
 |                       *===============>*                 |
 |                       |              (SIM 1)              |
 |                       |                   |                 |
```
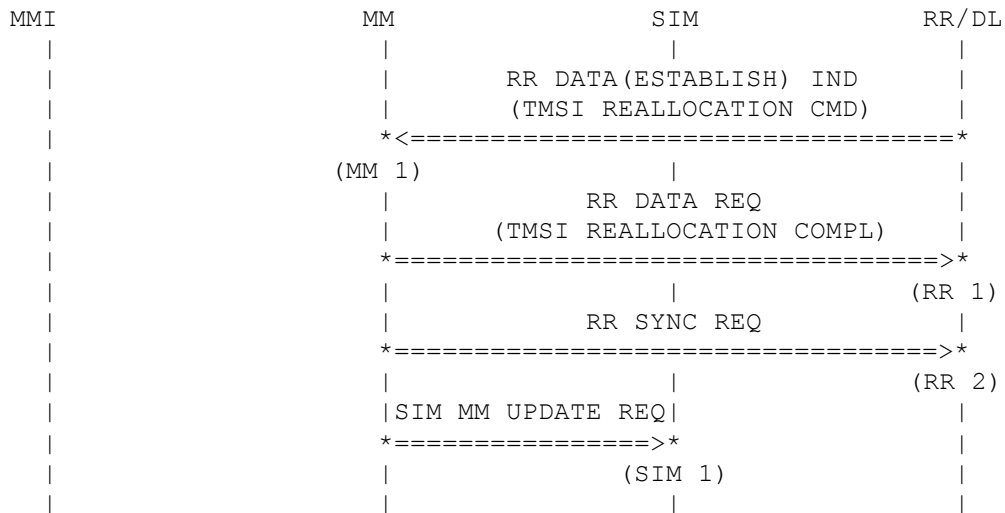
(MM 1)
During Location Updating or during a normal call the infrastructure may allocate a new TMSI. There-
fore the TMSI Reallocation procedure is started. MM receives the TMSI Reallocation Command mes-
sage including the new TMSI.
(RR 1)
MM stores the new TMSI and acknowledges the message with a TMSI Reallocation Complete to the
infrastructure.
(RR 2)
RR is informed about the new TMSI.
(SIM 1)
The TMSI is stored on the SIM card.

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10 Authentication

10.1 Initiation by the Network

```
MMI                      MM                SIM              RR/DL
 |                       |                 |                 |
 |                       |       RR DATA(ESTABLISH) IND      |
 |                       |         (AUTHENTICATION REQ)      |
 |                       *<================================* |
 |                      (MM 1)              |                 |
 |                       |SIM AUTHENTIC REQ|                 |
 |                       *===============>* |                 |
 |                       |            (SIM 1)                |
 |                       |SIM AUTHENTIC CNF|                 |
 |                       *===============>* |                 |
 |                      (MM 2)              |                 |
 |                       |        RR DATA REQ               |
 |                       |     (AUTHENTICATION RESP)        |
 |                       *===============================>* |
 |                       |                 |         (RR 1)  |
 |                       |        RR SYNC REQ              |
 |                       *===============================>* |
 |                       |                 |         (RR 2)  |
 |                       |                 |                 |
```
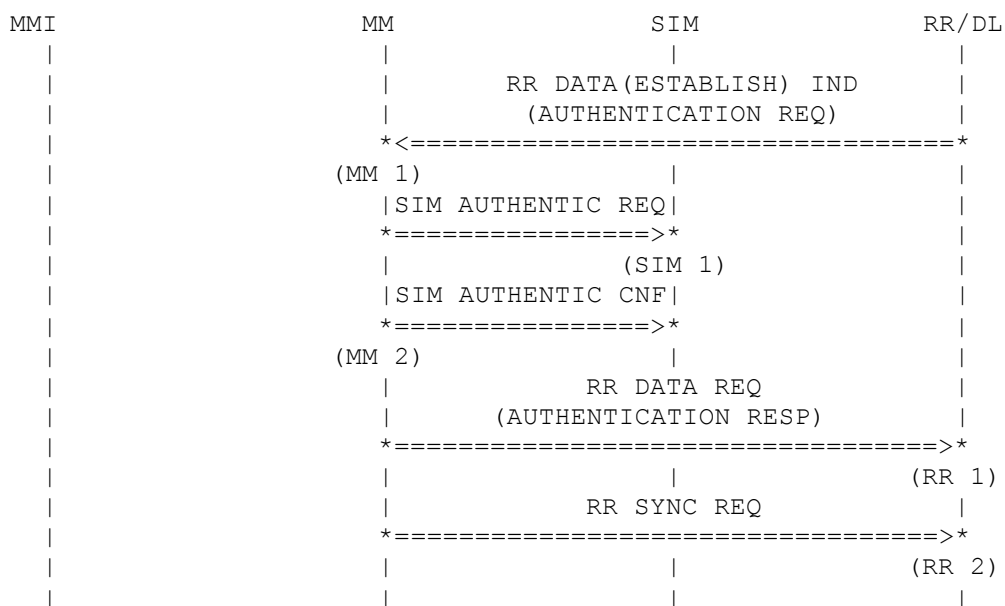
(MM 1)
During Location Updating or a normal call the infrastructure may request the authentication parameters from the mobile station. Therefore a Authentication Request message is send to the mobile station with the input parameters of the GSM algorithm on the SIM card.
(SIM 1)
This parameters are send to the SIM application. On the SIM card the GSM algorithm is running.
(MM 2)
The result of this procedure on the SIM card are the authentication result parameter SRES and the cipher key Kc.
(RR 1)
The authentication result parameter SRES is send back to the infrastructure with an Authentication Response message.
(RR 2)
The cipher key Kc is forwarded to RR for ciphering purposes.

10.1.1 Receiving of MM INFORMATION message during authentication

```
MMI/CM                    MM                  SIM              RR/DL
  |                        |                   |                |
  |                        |            RR_DATA_IND             |
  |                        |         (AUTHENTICATION REQ)       |
  |                        *<================================*
  |                        |                   |                |
  |                        |SIM AUTHENTIC REQ|                   |
  |                        *===============>*                    |
  |                        |                (SIM 1)              |
  |                        |                   |                |
  |                        |            RR_DATA_IND             |
  |                        |           (MM_INFORMATION)         |
  |                        *<================================*
  |  MMR_INFO_IND          |                   |                |
  *<==================*                        |                |
  |                      (MM 1)                 |                |
  |                        |                   |                |
  |                        |SIM AUTHENTIC CNF|                   |
  |                        *<===============*                    |
  |                      (MM 2)               |                |
  |                        |            RR DATA REQ             |
  |                        |        (AUTHENTICATION RESP)       |
  |                        *================================>*
  |                        |                   |                |
  |                        |             RR SYNC REQ           |
  |                        *================================>*
  |                        |                   |                |
```
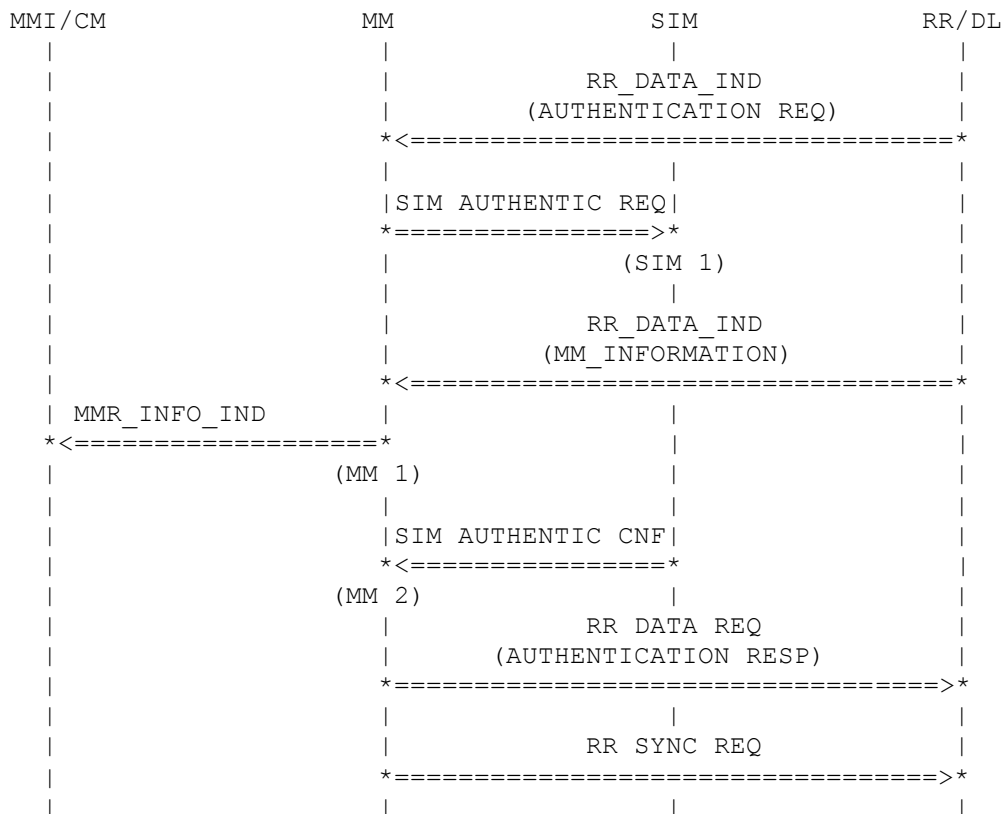
(SIM 1)
The mobile station has received the AUTHENTICATION REQUEST message with the value RAND. The SIM is processing the value SRES. This will take a short time. Normally during this time no traffic is seen on the air interface and the network is waiting for the AUTHENTICATION RESPONSE message.
(MM 1)
Here the waiting time is used by the network to submit some information to the mobile station. This may happen at any time a RR connection to the network exists, but the time between AUTHENTICATION REQUEST and AUTHENTICATION response is proposed by GSM 04.08 not to lengthen signalling time on the air interface. In this scenario, the MMR_INFO_IND primitive containing the informations received by the MM_INFORMATION message may be send before or after the mobile station has indicated that it is registered to upper layers by the primitive MMR_REG_IND.
(MM 2)
Normal authentication procedure is following.

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10.2 Rejection by the Network

```
MMI                     MM                  SIM              RR/DL
 |                       |                   |                |
 |                       |        RR DATA(ESTABLISH) IND      |
 |                       |           (AUTHENTICATION REJ)     |
 |                       *<================================*
 |                   (MM 1)                  |                |
 |                       |SIM MM UPDATE REQ| |                |
 |                       *===============>*                  |
 |                       |              (SIM 1)               |
 |                       |           RR SYNC REQ              |
 |                       *================================>*
 |                       |                   |            (RR 1)
 |                       |                   |                |
```
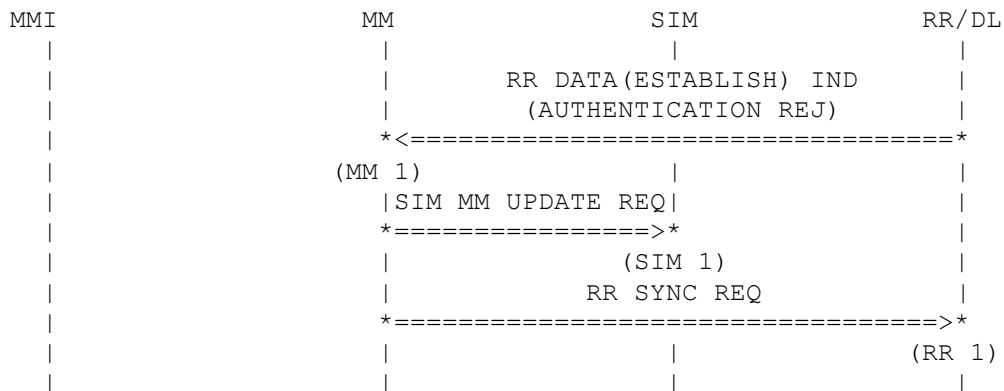
(MM 1)
Parallel to the calculation in the mobile station the same calculations are processed in the infrastructure. If the result of the mobile station doesn´t match with the result of the infrastructure an authentication failure is detected. This is signalled to the mobile station with an Authentication Reject message. MM deletes the registration parameters.

(SIM 1)
Registration parameters like TMSI and Kc are deleted on the SIM card.

(RR 1)
RR is informed about the authentication failure.

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11 Identification

```
MMI                     MM                  SIM              RR/DL
 |                      |                   |                 |
 |                      |         RR DATA IND                 |
 |                      |        (IDENTITY REQUEST)           |
 |                      *<================================*
 |                      (MM 1)               |                 |
 |                      |         RR DATA REQ                 |
 |                      |        (IDENTITY RESPONSE)          |
 |                      *================================>*
 |                      |                   |         (RR 1)
 |                      |                   |                 |
```
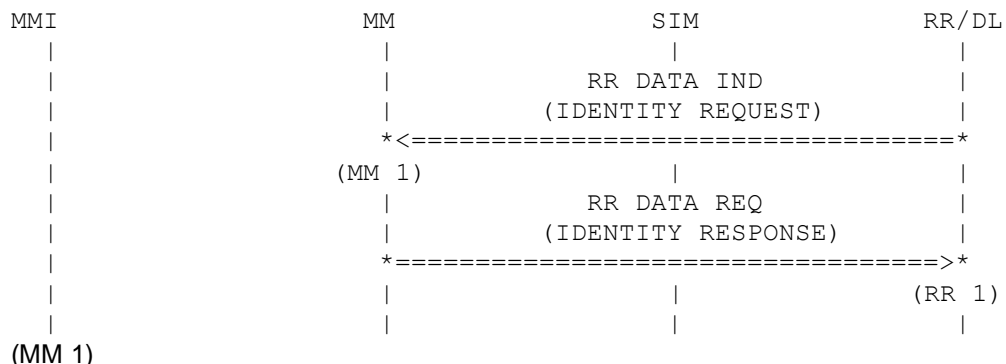
(MM 1)
If requested by the infrastructure the identification procedure is started. This is processed during a location updating or a normal call. Therefore the infrastructure sends an Identity Request message to the mobile station. The mobile identity type defines the requested identity (IMSI, TMSI, IMEI or IMEISV).

(RR 1)
MM responses with an Identity Response message and the corresponding mobile identity.

12 MM-Connection Management

12.1 Mobile Originated Call Initiation

```
MMI/CM                    MM                    SIM                 RR/DL
  |                        |                     |                    |
  | MMXX ESTABLISH REQ |                         |                    |
  *==================>*                          |                    |
  |                 (MM 1)                        |                    |
  |                        |                     |                    |
  |                        |      RR ESTABLISH(DATA) REQ              |
  |                        |         (CM SERVICE REQUEST)             |
  |                        *================================>*
  |                        |                     |              (RR 1)
  |                        |                     |                    |
```
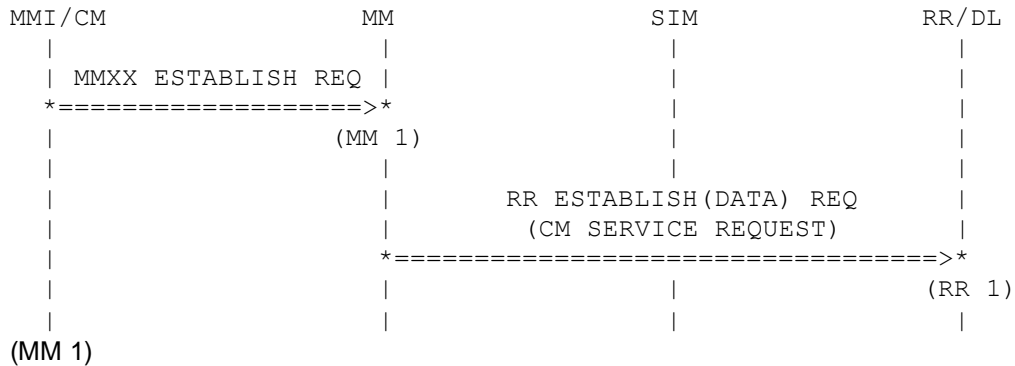
(MM 1)
A CM connection is requested by an CM entity with an MMXX_ESTABLISH_REQ primitive. XX stands for either CC, SS or SMS. The used transaction identifier is in the range 0 to 6.
(RR 1)
Depending on whether already a RR connection exists, MM uses the RR ESTABLISH REQ or RR DATA REQ primitive to forward the inital CM Service Request message describing the requested service from the upper layer.

12.2 Mobile Originated Call - RR - Connection

```
MMI/CM                   MM                    SIM              RR/DL
  |                       |                     |                 |
a) successfull case
  |                       |                     |                 |
  |                       |           RR ESTABLISH CNF            |
  |                      *<=====================================* |
  |                    (MM 1)                    |                 |
  |                       |                     |                 |
b) negative end, random access failed, redialling
  |                       |                     |                 |
  |                       |           RR RELEASE IND              |
  |                      *<=====================================* |
  |                    (MM 2)                    |                 |
  |                       |     RR ESTABLISH(DATA) REQ            |
  |                       |       (CM SERVICE REQUEST)           |
  |                      *=====================================>* |
  |                       |                     |            (RR 1)
  |                       |                     |                 |
c) negative end, random access failed, no redialling
  |                       |                     |                 |
  |                       |           RR RELEASE IND              |
  |                      *<=====================================* |
  |                    (MM 3)                    |                 |
  | MMXX RELEASE IND      |                     |                 |
 *<==================*    |                     |                 |
(CM 1)                    |                     |                 |
  |                       |                     |                 |
c) negative end, other causes
  |                       |                     |                 |
  |                       |           RR RELEASE IND              |
  |                      *<=====================================* |
  |                    (MM 4)                    |                 |
  | MMXX RELEASE IND      |                     |                 |
 *<==================*    |                     |                 |
(CM 1)                    |                     |                 |
  |                       |                     |                 |
```
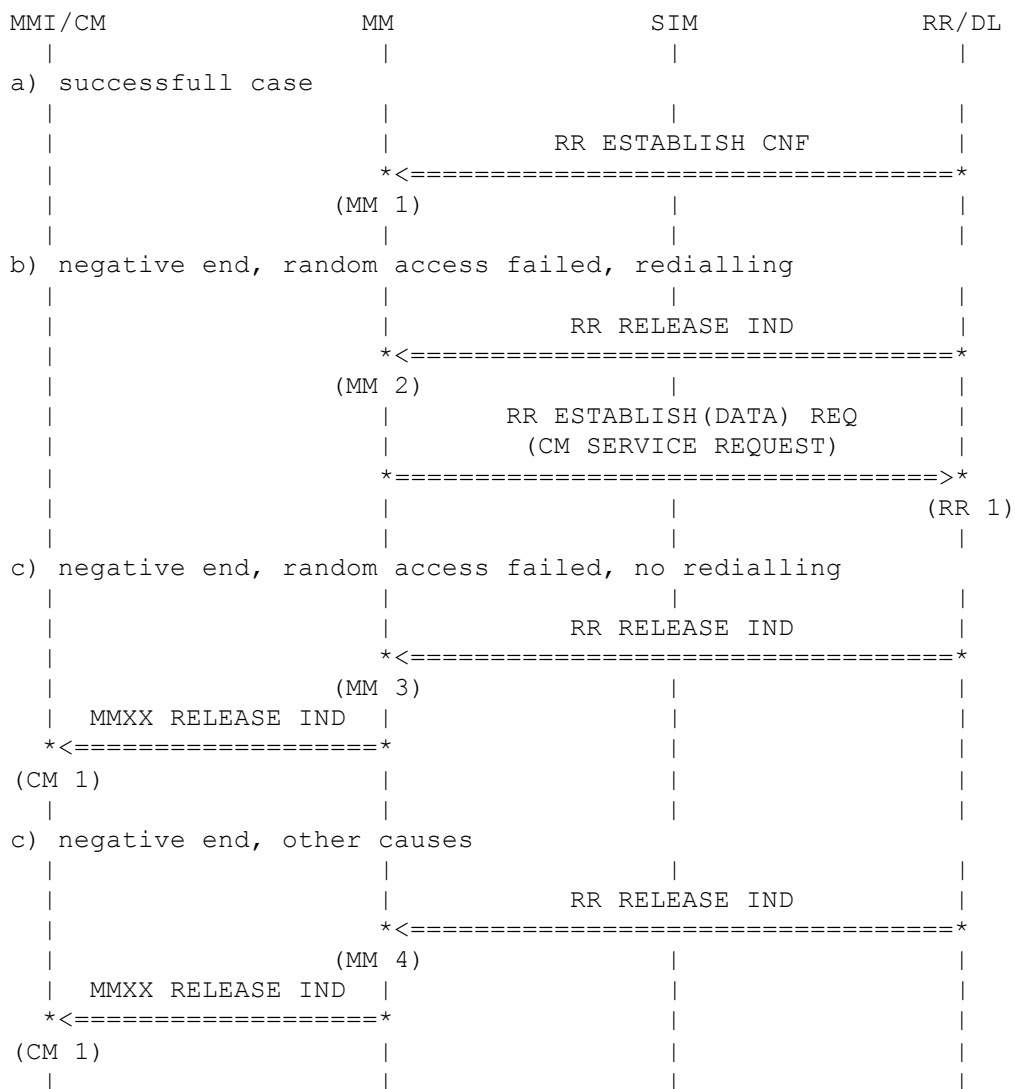
(MM 1)
The RR connection is established. MM starts T3240 and waits for the response of the network.
(MM 2)
The establishment of the RR connection has failed. The cause is random access failed. That means the mobile has not allocated a resource on the air-interface.
(RR 1)
If no test SIM card is inserted, MM starts an internal auto redialling.
(MM 3)
The establishment of the RR connection has failed. The cause is random access failed. That means the mobile has not allocated a resource on the air-interface. A redialling is not possible, because a Test SIM card is inserted or the maximum of re-attempts are made.
(CM 1)
The release cause is forwarded to CC, SS or SMS.
(MM 4)
The RR connection establishment has failed due to other causes.

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12.3 Mobile Originated Call Established

```
MMI/CM                   MM                   SIM                 RR/DL
  |                       |                    |                    |
  |                       |              RR DATA IND                |
  |                       |          (CM SERVICE ACCEPT)            |
  |                      *<================================*
  |                    (MM 1)                  |                    |
  |                       |               RR SYNC IND               |
  |                       |             (ciphering on)              |
  |                      *<================================*
  |                    (MM 2)                  |                    |
  |                       |                    |                    |
  | MMXX ESTABLISH CNF    |                    |                    |
  *<==================*                        |                    |
(CM 1)                    |                    |                    |
  |                       |                    |                    |
```
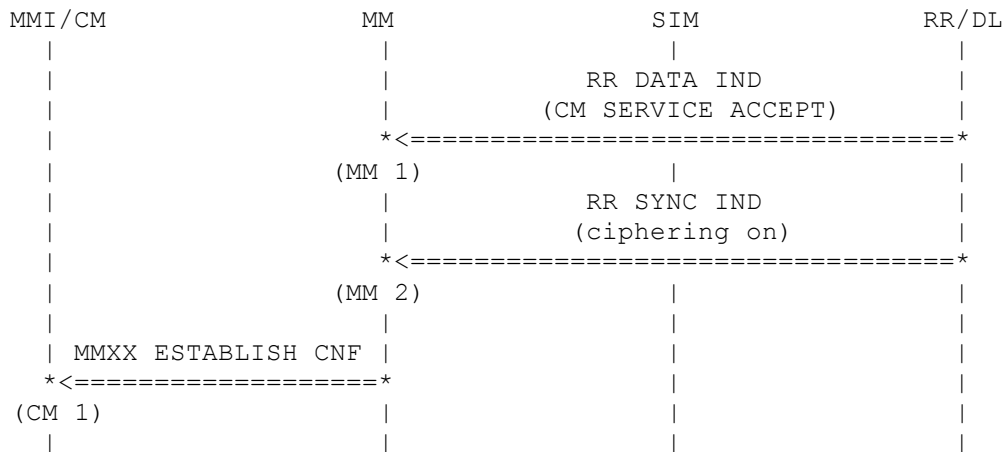
(MM 1)
If the infrastructure is able to process the requested service, it sends a CM Service Accept message to MM.
(MM 2)
Alternatively ciphering is configured by the network.
(CM 1)
For the requested CM connection (CC, SS or SMS) an establishment confirmation is send to the appropriate CM entity.

12.4 Mobile Originated Call - No Answer from the network

```
MMI/CM                     MM                    SIM                  RR/DL
   |                        |                     |                    |
   |                        *<timeout T3230>      |                    |
   |                       (MM 1)                 |                    |
   |                        |                     |                    |
   |   MMXX RELEASE IND      |                     |                    |
   *<===================*                     |                    |
(CM 1)                      |                     |                    |
   |                        |                     |                    |
   |                        *<timeout T3240>      |                    |
   |                        |            RR_ABORT_REQ                  |
   |                        *===============================>*
   |                       (MM 2)                 |                    |
   |                        |                     |                    |
   |                        |            RR_RELEASE_IND                |
   |                        *<===============================*
   |                        |                     |                    |
   |                        |            MDL_RELEASE_REQ               |
   |                        *===============================>*
   |                        |                     |           (RR 1)
   |                        |                     |                    |
```
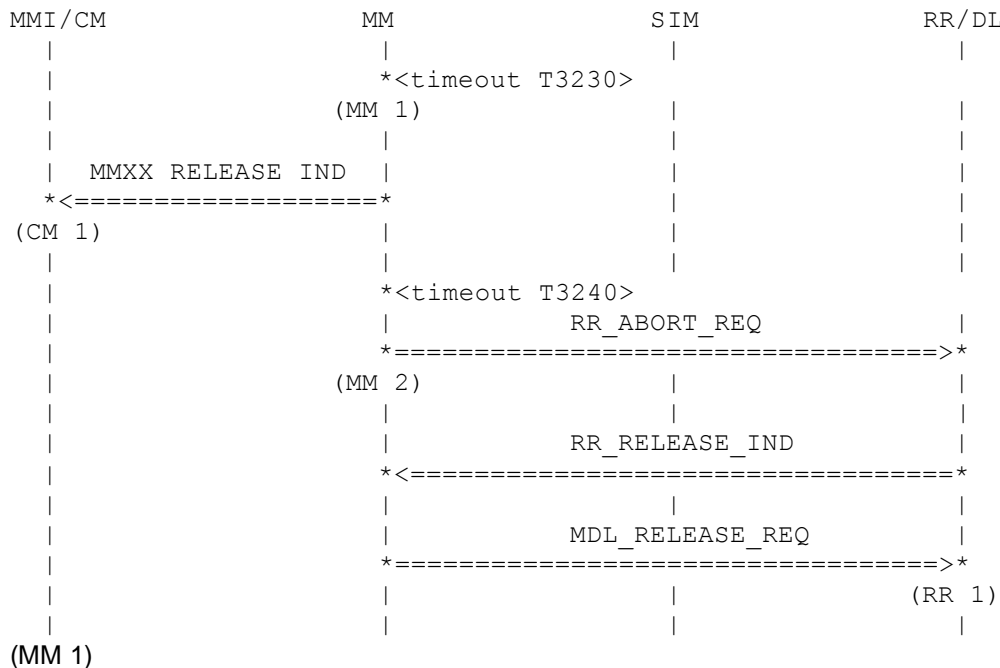
(MM 1)

The answer of the network is controlled by timer T3230. The network didn't answer the CM SERVICE REQUEST from MM, so the timer T3230 expired.

(CM 1)

The CM entity which requested the connection is informed by means of MMXX_RELEASE_IND that the connection establishment failed. XX stands for the respective CM entity, this is either CC, SS or SMS. MM starts timer T3240 and enters state MM_WAIT_FOR_NW_CMD.

(MM 2)

It is assumed that the networks doesn't react in any way, e.g. the ongoing RR connection is not terminated by the network by means of CHANNEL RELEASE message, no RR_RELEASE_IND is received. Timer T3240, which supervises state MM_WAIT_FOR_NW_CMD expired. MM sends an RR_ABORT_REQ to RR, awaiting the RR_RELEASE_IND from RR after L2 release. MM remains in state MM_WAIT_FOR_NW_CMD.

(RR 1)

RR informs MM about the release of the L2 connection by sending an RR_RELEASE_IND primitive. There is no dedicated circuit switched connection to the network in any layer now anymore. MM enters IDLE state.

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12.5 Mobile Originated Call - Rejected (IMSI unknown in VLR)
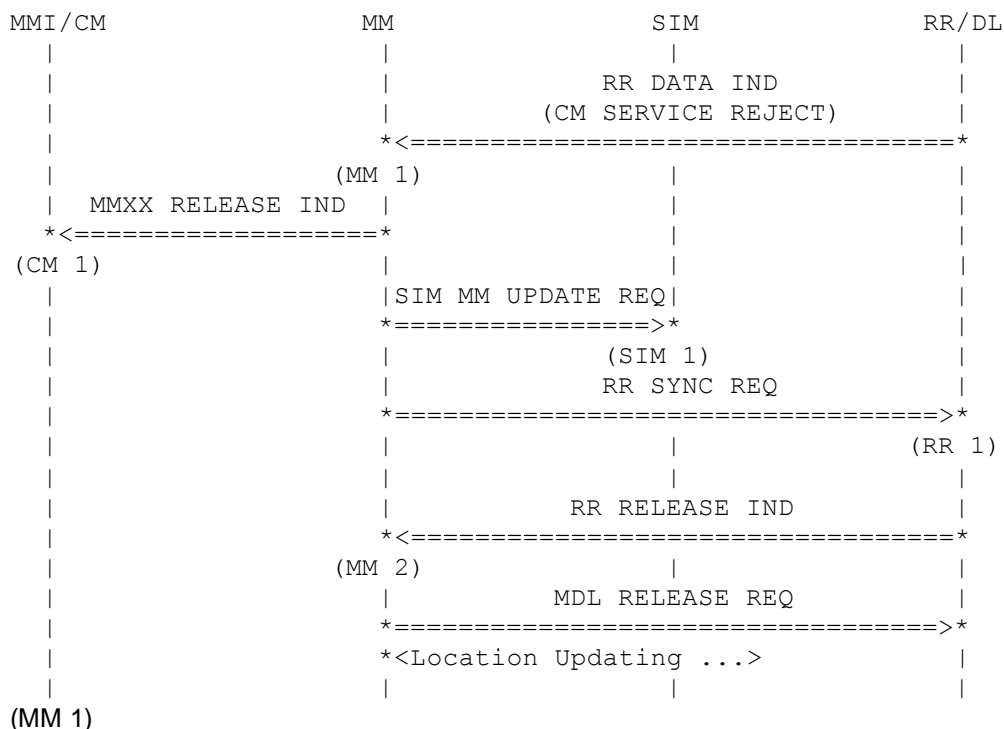
```
MMI/CM                    MM                  SIM              RR/DL
   |                       |                   |                 |
   |                       |              RR DATA IND            |
   |                       |           (CM SERVICE REJECT)       |
   |                       *<===============================*
   |                     (MM 1)                |                 |
   |  MMXX RELEASE IND     |                   |                 |
  *<==================*                        |                 |
(CM 1)                     |                   |                 |
   |                       |SIM MM UPDATE REQ|                   |
   |                       *===============>*                    |
   |                       |              (SIM 1)                |
   |                       |              RR SYNC REQ            |
   |                       *===============================>*
   |                       |                   |            (RR 1)
   |                       |                   |                 |
   |                       |              RR RELEASE IND         |
   |                       *<===============================*
   |                     (MM 2)                |                 |
   |                       |          MDL RELEASE REQ            |
   |                       *===============================>*
   |                       *<Location Updating ...>              |
   |                       |                   |                 |
```

(MM 1)
The infrastructure rejects the acceptance of CM service. Therefore a CM Service Reject message is send to MM. The cause is IMSI unknown in VLR. This cause is possible if the mobile has used a TMSI which is not allocated to an IMSI in the infrastructure. This may happen if there was a network failure (VLR database screwed up) or in some clash cases, e.g. RR_ESTABLISH_REQ (stored in RR) => RR_ACTIVATE_IND (cell selection to new location area) => RR establishment to cell in location area where the mobile station is not registered.

(CM 1)
The CM entity which requested the connection is informed by means of MMXX_RELEASE_IND that the connection establishment failed. XX stands for the respective CM entity, this is either CC, SS or SMS. MM starts timer T3240 and enters state MM_WAIT_FOR_NW_CMD. It has to be mentioned here that it is an implementation option to store the CM establish attempt in this situation until registration is regained after a successful registration procedure. The current G23 implementation currently doesn't support this option.

(SIM 1)
The SIM is informed that the registration was lost, update state is "NOT UPDATED" now, TMSI, CKSN and KC are invalidated on the SIM.

(RR 1)
RR is informed about the loss of registration, TMSI, CKSN and KC are invalidated in RR.

(MM 2)
The RR connection has been released. MM sends an MDL_RELEASE_REQ to the data link layer. IDLE state has been reached (MM_IDLE_ATTEMPT_TO_UPDATE), but this IDLE state is a transient state here. A normal location updating procedure is started immediately to regain registration.

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12.6 Mobile Originated Call - Rejected (Illegal ME)
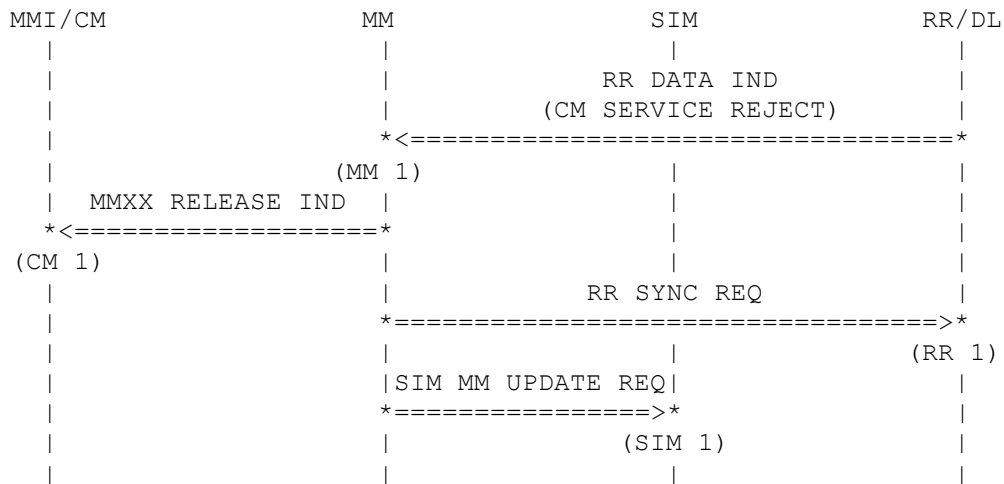
```
MMI/CM                   MM                   SIM                 RR/DL
  |                      |                     |                    |
  |                      |            RR DATA IND                   |
  |                      |         (CM SERVICE REJECT)              |
  |                      *<================================*        |
  |                    (MM 1)                  |                    |
  |  MMXX RELEASE IND    |                     |                    |
  *<==================*                        |                    |
(CM 1)                  |                     |                    |
  |                      |            RR SYNC REQ                    |
  |                      *================================>*        |
  |                      |                     |          (RR 1)    |
  |                      |SIM MM UPDATE REQ|                        |
  |                      *===============>*                         |
  |                      |            (SIM 1)                        |
  |                      |                     |                    |
```

(MM 1)

The infrastructure rejects the acceptance of CM service. Therefore a CM Service Reject message is send to MM. The cause is Illegal Mobile Equipment. This cause is possible if the mobile has an undefined IMEI.

(CM 1)

The CM entity which requested the connection is informed by means of MMXX_RELEASE_IND that the connection establishment was rejected by the infrastructure. XX stands for the respective CM entity, this is either CC, SS or SMS.

(RR 1)

The registration parameters in RR are deleted, including IMSI.

(SIM 1)

The registration parameter on the SIM card are deleted, new update state is "ROAMING NOT ALLOWED". The SIM is considered as invalid by the mobile station until SIM removal or power cycle.

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12.7 Mobile Originated Call - Rejected (other causes)

```
MMI/CM                      MM                  SIM                 RR/DL
  |                          |                   |                   |
  |                          |            RR DATA IND                |
  |                          |         (CM SERVICE REJECT)           |
  |                          *<===================================*
  |                      (MM 1)                  |                   |
  |   MMXX RELEASE IND   |                       |                   |
  *<===================*                         |                   |
(CM 1)                    |                       |                   |
  |                       |                       |                   |
```
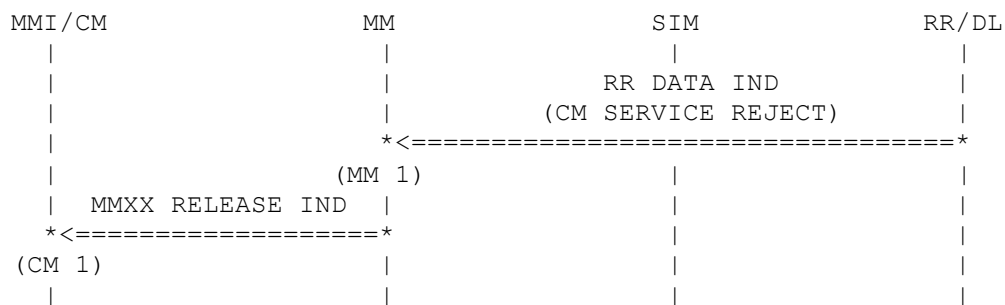
(MM 1)
Other reject causes are send with a CM Service Reject message to MM.
(MMI 1)
The CM entity which requested the connection is informed by means of MMXX_RELEASE_IND that the connection establishment was rejected by the infrastructure. XX stands for the respecti ve CM enti-ty, this is either CC, SS or SMS.

12.8 Mobile Terminated Call

```
MMI/CM                    MM                  SIM                 RR/DL
  |                        |                   |                   |
  |                        |           RR DATA IND                 |
  |                        |          (CM MESSAGE)                 |
  |                       *<================================*
  |                     (MM 1)                 |                   |
  | MMXX ESTABLISH IND |                       |                   |
  *<==================*                        |                   |
(CM 1)                    |                     |                   |
  |                        |                   |                   |
```

(MM 1)
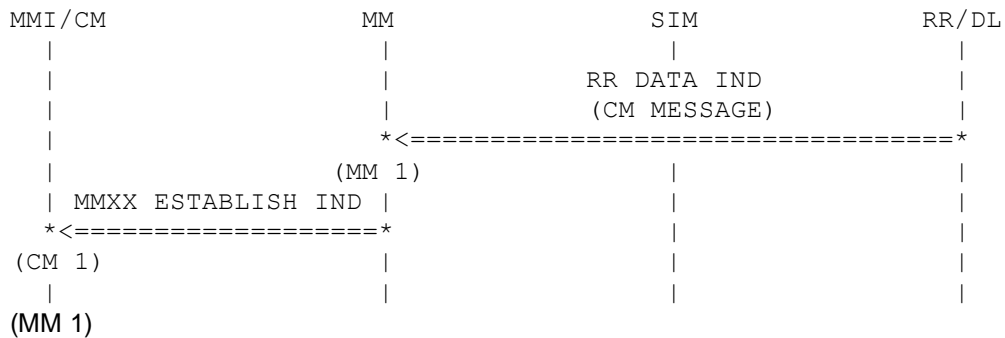
A new mobile terminated connection is started by the infrastructure by sending the first CM message. MM checks the protocol discriminator and transaction identifier of the message. If it is a new transaction it remarks this in its call administration.

(CM 1)

The message is forwarded to the appropriate CM entity according to the protocol discriminator of the message (either CC, SS or SMS).

12.9 CM Message Transfer

```
MMI/CM                    MM                 SIM                RR/DL
   |                      |                   |                  |
   |    MMXX DATA REQ     |                   |                  |
   *===================>*                     |                  |
   |                     (MM 1)               |                  |
   |                      |       RR DATA REQ                    |
   |                      *================================>*    |
   |                      |                   |            (RR 1) |
   |                      |       RR DATA IND                    |
   |                      *<================================*    |
   |                     (MM 2)               |                  |
   |    MMXX DATA IND     |                   |                  |
   *<==================*                      |                  |
(CM 1)                    |                   |                  |
   |                      |                   |                  |
```
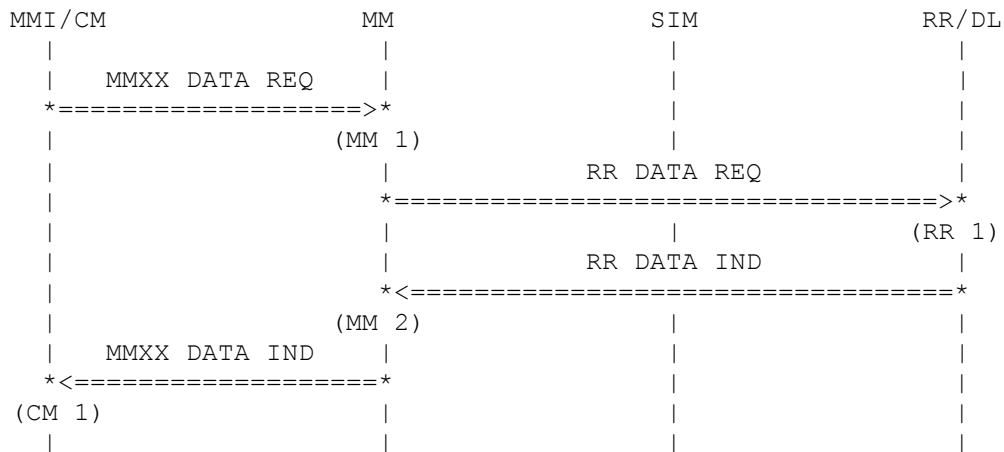
(MM 1)

For an existing CM connection a CM entity send a CM message via MM to the infrastucture by means of the MMXX DATA REQ primitive. XX stands for either CC, SS or SMS.

(RR 1)

MM forwards the message to RR.

(MM 2)

Incoming message on existing transactions are forwarded by MM.

(CM 1)

MM checks the protocol discriminator of the message and distributes the message to either CC, SS or SMS.

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12.10 CCBS Call Setup

```
MMI/CM                    MM                  SIM              RR/DL
   |                       |                   |                |
   |                       |            RR_DATA_IND             |
   |                       |         (CM SERVICE PROMPT)        |
   |                       *<================================*
   |                      (MM 1)               |                |
   |                       |                   |                |
a) The addressed entity is CC, SAPI=0
   |                       |                   |                |
   | MNCC_PROMPT_IND       |                   |                |
   *<==================*   |                   |                |
(CC 1)                     |                   |                |
   |                       |                   |                |
b) Any other values for CM or SAPI
   |                       |                   |                |
   |                       |            RR_DATA_REQ             |
   |                       |             (MM_STATUS)            |
   |                       *================================>*
   |                      (MM 2)               |                |
   |                       |                   |                |
c) Following a), a ti is assigned, CC sends first CM msg
   |                       |                   |                |
   | MNCC_PROMPT_RSP       |                   |                |
   *==================>*   |                   |                |
   |                       |                   |                |
   | MNCC_DATA_REQ         |                   |                |
   | (START CC)            |                   |                |
   *==================>*   |                   |                |
   |                       |            RR_DATA_REQ             |
   |                       |             (START CC)             |
   |                       *================================>*
(CC 2)                     |                   |                |
   |                       |                   |                |
d) Out of transaction identifiers or some other error
   |                       |                   |                |
   | MNCC_PROMPT_REJ       |                   |                |
   *==================>*   |                   |                |
   |                       |            RR_DATA_REQ             |
   |                       |             (MM_STATUS)            |
   |                       *================================>*
(CC 3)                     |                   |                |
   |                       |                   |                |
```

(MM 1)
The MM entity is prompted for a connection management service by the network. A SAPI and a CM
entity is given by the message. A RR connection to the network exists.
(CC 1)
If the CM entity given by the CM SERVICE PROMPT message equals to CC, the SAPI eqals to zero
and MM is in a compatible protocol state, the mobile may be able to process the request. This is the
normal (successfull) case, CC is informed about the CM SERVICE PROMPT by emission of the
MNCC_PROMPT_IND primitive and MM will enter the state MM_PROCESS_PROMPT.
(MM 2)
This is the error case. Either MM was not in a compatible protocol state or the adressed CM entity was
not CC or the addressed SAPI was not zero. The CM SERVICE PROMPT request is rejected by an
MM_STATUS message either with cause "Illegal protocol state".or "Service option not supported". If

MM connections are remaining, MM will re-enter the state MM_CONN_ACTIVE, otherwise MM will enter the state MM_WAIT_FOR_NW_CMD.

(CC 2)

Following a), CC was able ro request a free mobile originated transaction identifier. This is assigned by emission of the primitive MNCC_PROMPT_RSP. From now on MM considers the CM connection as active, MM will forward CC data from and to the network by using MMCC_DATA_REQ and MMCC_DATA_IND. MM changes its state to MM_CONN_ACTIVE. The first CM message follows immediately the primitive MNCC_PROMPT_RSP, CC informs the network about the newly assigned mobile originated transaction identifier by this message.

(CC 3)

Following a), CC was not able to acquire a transaction identifier or some other problem may have occured. The CM SERVICE PROMPT request is rejected by an MM_STATUS message with cause "Service option temorarily out of order". If MM connections are remaining, MM will re-enter the state MM_CONN_ACTIVE, otherwise MM will enter the state MM_WAIT_FOR_NW_CMD.

13 DL Error handling (Obsolete)

DL error handling was in former days present in MM. This is handled in DL directly now, and every MDL_ERROR_IND received by MM will be ignored without causing further action. But the handling routines have not been removed in the C code until now, neither from DL nor from MM, but only disabled. Therefore, this chapter is still present in this document and has not yet been removed also.

```
MMI                     MM                      SIM                     RR/DL
 |                       |                       |                       |
 |                       |            MDL ERROR IND                      |
 |                      *<=================================*             |
 |                     (MM 1)                    |                       |
 |                       |                       |                       |
a) high priority error
 |                       |                       |                       |
 |                       |            MDL RELEASE REQ        |           |
 |                      *=================================>*             |
 |                       |                       |        (DL 1)         |
 |                       |                       |                       |
b) medium priority error, too often
 |                       |                       |                       |
 |                       |            MDL RELEASE REQ        |           |
 |                      *=================================>*             |
 |                       |                       |        (DL 2)         |
 |                       |                       |                       |
c) medium priority error, not too often
 |                       |                       |                       |
 |                       *                       |                       |
 |                     (MM 2)                    |                       |
 |                       |                       |                       |
d) low priority error
 |                       |                       |                       |
 |                       *                       |                       |
 |                     (MM 3)                    |                       |
 |                       |                       |                       |
e) Timeout T100
 |                       |                       |                       |
 |                      *<Timeout T100>          |                       |
 |                     (MM 4)                    |                       |
 |                       |                       |                       |
```
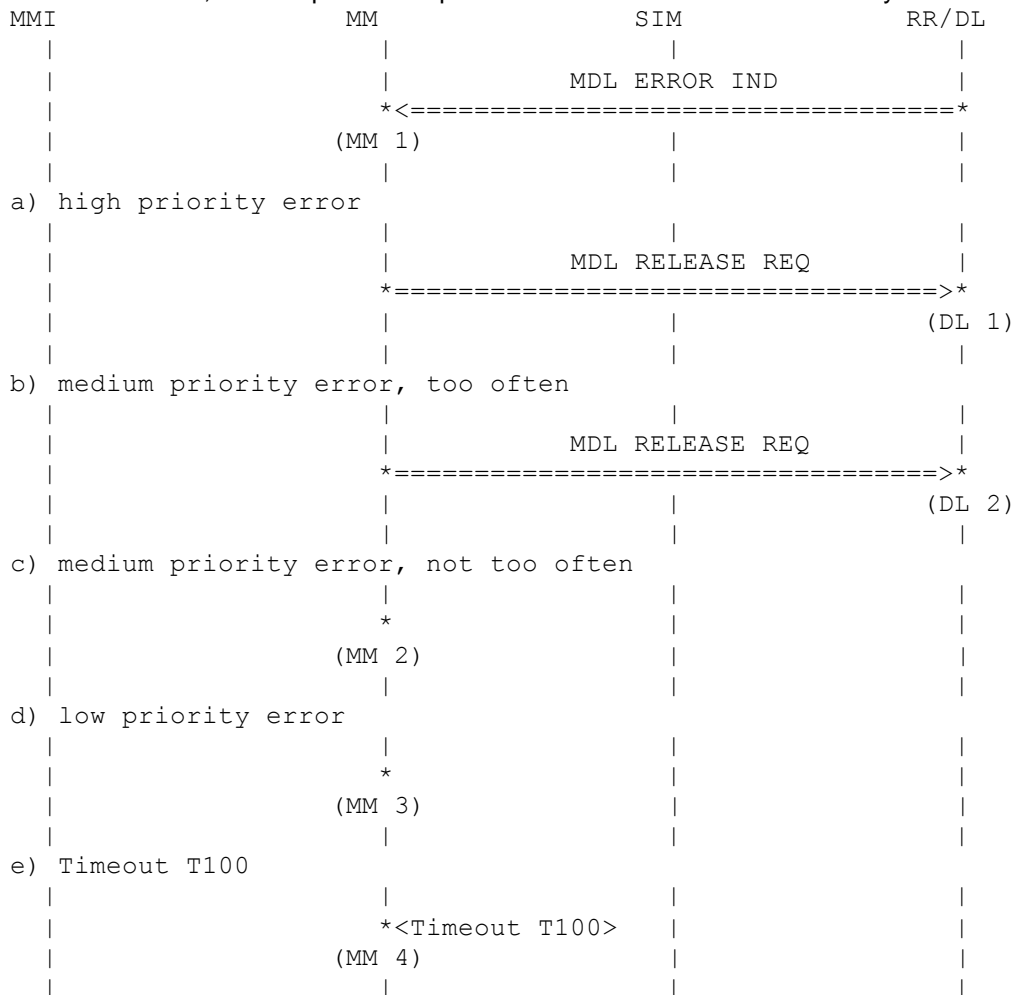
(MM 1)
Whenever DL has detected an error it sends this error to MM.
(DL 1)
If it is a high priority error the DL connection is released immediately.
(DL 2)
If it is a medium priority error and to many error coming during one T100 interval (started after the first medium priority error), the DL connection is released immediately.
(MM 2)
A medium priority error has received. If it is the first medium priority error the timer T100 is started. A counter for this type of errors is started. The counter will not reach the boarder value and nothing happens.
(MM 3)
A low priority error has received. It is ignored.
(MM 4)
The timer T100 times-out. This resets the medium priority error counter. The counter is defined separately for SAPI 0 and 3.

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The following table shows the priority of data link layer errors:

Error	Coding	Priority
re-establishment request	1	LOW
unsolicited UA response	2	
U frame with incorrect parameters	7	
S frame with incorrect parameters	8	
SABM command with information field not allowed in this state	13	
unsolicited supervisory response	5	MEDIUM
sequence error	6	
I frame with incorrect use of M bit	9	
I frame with incorrect length	10	
frame not implemented	11	
SABM command, multiple frame established state	12	
T200 expired (N200 + 1 times)	0	HIGH
unsolicited DM response	3	
unsolicited DM response, multiple frame established state	4	
N(R) sequence error, perform abnormal release	14	

14 GPRS Registration and deregistration

14.1 Cell search for GMM

```
GMM                      MM                     SIM                   RR/DL
a) Switch on
  |                       |                      |                     |
  |                       | SIM_MM_INSERT_IND    |                     |
  |                       *<===================* |                     |
  |                      (MM 1)                   |                     |
  | MMGMM_PLMN_RES        |                      |                     |
  *===================>*                          |                     |
  |                      (MM 2)                   |                     |
  | MMGMM_REG_REQ         |                      |                     |
  *===================>*                          |                     |
  |                       |         RR_ACTIVATE_REQ                    |
  |                       *====================================>*
  |                       |                      |                     |
b) successful cell search
  |                       |         RR_ACTIVATE_CNF                    |
  |                       *<====================================*
  |                       |                      |                     |
  | MMGMM_ACTIVATE_IND    |                      |                     |
  *<===================*                          |                     |
(GMM 1)                   |                      |                     |
  |                       |                      |                     |
c) non-successful cell search
  |                       |                      |                     |
  |                       |          RR_ABORT_IND                      |
  |                       *<====================================*
  | MMGMM_NREG_IND        |                      |                     |
  *<===================*                          |                     |
(GMM 2)                   |                      |                     |
  |                       |                      |                     |
```
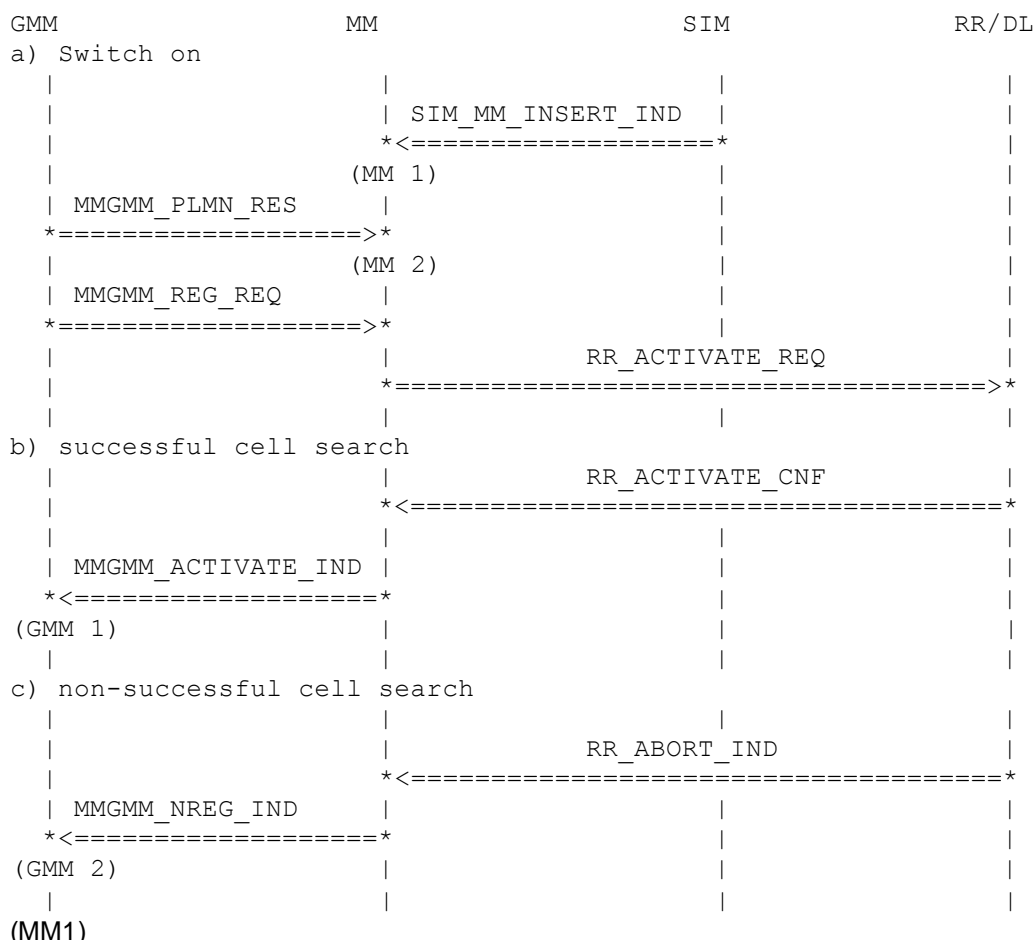
(MM1)
A SIM was inserted into the MS which need to PIN to be enabled, thus the SIM data is immediately present after switch on and no registration to limited service in parallel to PIN entering need to be per-formed.
(MM 2)
The mode is switched by upper layers to automatic network search mode. This is also the default.
(MM 3)
MM is required to perform a cell search. The parameters for MMGMM_REG_REQ are full service required, cell search only. RR is activated, SIM data is delivered to RR and it is announced to RR that GPRS is wanted.
(GMM 1)
After successful cell selection in RR, MM copies the cell data into its own data structures. GMM is informed that a suitable cell was found. In case an update (either IMSI ATTACH or NORMAL UPDATE) is needed, MM will not perform this on its own, but waits in state IDLE, LOCATION UPDATING NEEDED for GMM to decide about this.
(GMM 2)
After having performed step a), a suitable cell could not be found. The service is either no service or limited service, the new main state is either IDLE, LIMITED SERVICE or IDLE, NO SERVICE. GMM is informed about this by MMGMM_NREG_IND with appropriate cause value.

14.2 Remote controlled update by MM's own procedures, successful

```
GMM                          MM                          SIM                  RR/DL
a) Successful cell selection in RR, full service possible
  |                           |                           |                    |
  |                           |            RR_ACTIVATE_CNF |                    |
  |                           *<=======================================*
  |                           |                           |                    |
  |     MMGMM_ACTIVATE_IND     |                           |                    |
  *<=====================*                                 |                    |
(GMM 1)                       |                           |                    |
b) GMM requires update on the cell
  |                           |                           |                    |
  |     MMGMM_REG_REQ          |                           |                    |
  *=====================>*                                 |                    |
  |                      (MM 1)                            |                    |
  |                           |            RR_ESTABLISH_REQ |                    |
  |                           |      (LOCATION UPDATING REQUEST)  |
  |                           *==========================================>*
  |                           |                           |                    |
  |                           |            RR_ESTABLISH_CNF |                    |
  |                           *<=======================================*
  |                           |                           |            (RR 1)
  |                           |                RR_DATA_IND |                    |
  |                           |        (AUTHENTICATION REQUEST)   |
  |                           *<=======================================*
  |                      (MM 2)                            |                    |
  |                           | SIM_AUTHENTICATION_REQ |                        |
  |                           *=======================>*                        |
  |                           |                           |                    |
  |                           | SIM_AUTHENTICATION_CNF |                        |
  |                           *<=======================*                        |
  |                      (MM 3)                            |                    |
  |                           |                RR_DATA_REQ |                    |
  |                           |      (AUTHENTICATION RESPONSE)    |
  |                           *==========================================>*
  |                           |                           |                    |
  |                           |                RR_SYNC_REQ |                    |
  |                           |                 (CKSN, KC) |                    |
  |                           *==========================================>*
  |                           |                           |                    |
  |                           |                RR_DATA_IND |                    |
  |                           |       (LOCATION UPDATING ACCEPT)  |
  |                           *<=======================================*
  |                      (MM 4)                            |                    |
  |                           |                RR_DATA_REQ |                    |
  |                           |        (TMSI REALLOC COMPLETE)    |
  |                           *==========================================>*
  |                           |                           |                    |
  |                           |                RR_SYNC_REQ |                    |
  |                           |                     (TMSI) |                    |
  |                           *==========================================>*
  |                           |                           |                    |
  |                           |                RR_SYNC_REQ |                    |
  |                           |        (LOCATION AREA ALLOW)      |
  |                           *==========================================>*
  |                           |                           |                    |
  | MMGMM_LUP_ACCEPT_IND      |                           |                    |
  *<=====================*                                 |                    |
```

```
|                     |                    |                     |
|  MMGMM_TMSI_IND     |                    |                     |
 *<====================*                    |                     |
|                     |                    |                     |
|                     | SIM_MM_UPDATE_REQ  |                     |
|                      *=====================>*                   |
|                     |                    |                     |
|                     |             RR_RELEASE_IND               |
|                      *<========================================*
|                   (MM 5)                  |                     |
|                     |             MDL_RELEASE_REQ              |
|                      *=========================================>*
|                     |                    |                     |
|  MMGMM_REG_CNF      |                    |                     |
 *<====================*                    |                     |
|                     |                    |                     |
```

(GMM 1)

After successful activation of a suitable cell, MM indicates the cell selection to GMM. GMM will also be informed that MM needs an update to obtain full service. MM is waiting in state IDLE, UPDATE NEEDED.

(MM 1)

GMM requires an update on the cell by MM's own procedures.

(RR 1)

MM establishes for location updating. The establishment is successful.

(MM 2)

The network starts the authentication procedure. The RAND is sent to the SIM.

(MM 3)

The SIM processed the SRES. This is sent to the network. At the same time the SIM processed also the ciphering parameters CKSN and KC. RR will be informed about the new ciphering parameters.

(MM 4)

The network accepted the location updating request and sent an LOCATION UPDATING ACCEPT message which included also a new TMSI. RR will be informed about the new TMSI and subsequently about the fact that the current location area is allowed for the mobile station. GMM is informed that a LOCATION UPDATING ACCEPT message has been received so that the new service state is "NORMAL SERVICE". GMM will inform the MMI about the full service condition and sothe MMI can celebrate this at the earliest possible point in time also. Subsequently the SIM will be informed about the new updated location area. As a new TMSI also has been allocated and GMM needs to know at least whether MM has a valid TMSI, the newly allocated TMSI is forwarded to GMM.

NOTE: The updating pocedure is not over if MMGMM_LUP_ACCEPT_IND has been sent. This is just to keep GMM informed about the new service state. The whole procedure will be over if either MMGMM_REG_CNF or MMGMM_NREG_IND is sent. This will be done after the RR connection has been released.

(MM 5)

RR sent the RR_RELEASE_IND. This is sent by RR after the layer 2 connection has been released. The layer 2 is reset and GMM is informed about the successful end of registration procedure by MMGMM_REG_CNF.

NOTE: It is important to understand here that RR sends the RR_RELEASE_IND primitive not immediately after the CHANNEL RELEASE message has been received, but after the confirmation that the layer 2 connection has been released also. As the MMGMM_REG_CNF (or, in case the procedure ended negative, the MMGMM_NREG_IND) indicates the absolute end of the updating procedure, the reception of MMGMM_REG_CNF in GMM may lead to an immediately switchover of the physical resources from the GSM side to the GPRS side. Any unfinished operation (as DISC/UA exchange) in lower layers may be affected by this, but it is ensured alyways in the internal protocol that the indication of the end of a circuit switched operation will be delayed until the circuit switched operation has been finished in all layers.

14.3 Remote controlled update by MM's own procedures, AUTH REJECT received

```
GMM                      MM                        SIM                  RR/DL
 |                        |                         |                    |
MM is in state MM_LUP_INITIATED, SIM_AUTHENTICATION_REQ has been sent.
 |                        |                         |                    |
 |                        | SIM_AUTHENTICATION_CNF  |                    |
 |                        *<========================*                    |
 |                       (MM 1)                      |                    |
 |                        |            RR_DATA_REQ                        |
 |                        |      (AUTHENTICATION RESPONSE)               |
 |                        *=========================================>*
 |                        |                         |                    |
 |                        |            RR_SYNC_REQ                        |
 |                        |              (CKSN, KC)                      |
 |                        *=========================================>*
 |                       (MM 2)                      |                    |
 |                        |            RR_DATA_REQ                        |
 |                        |       (AUTHENTICATION REJECT)               |
 |                        *=========================================>*
 |                        |            RR_SYNC_REQ                        |
 |                        |            (SIM invalid)                     |
 |                        *<=========================================*
 | MMGMM_TMSI_IND         |                         |                    |
 *<=====================*                           |                    |
 |                        | SIM_MM_UPDATE_REQ       |                    |
 |                        *=======================>*                    |
 | MMGMM_AUTH_REJ_IND     |                         |                    |
 *<=====================*                           |                    |
 |                        |                         |                    |
 |                        |            RR_RELEASE_IND                     |
 |                        *<=========================================*
 |                       (MM 3)                      |                    |
 |                        |            MDL_RELEASE_REQ                    |
 |                        *=========================================>*
 |                        |                         |                    |
 | MMGMM_REG_REJ          |                         |                    |
 *<=====================*                           |                    |
 |                        |                         |                    |
```
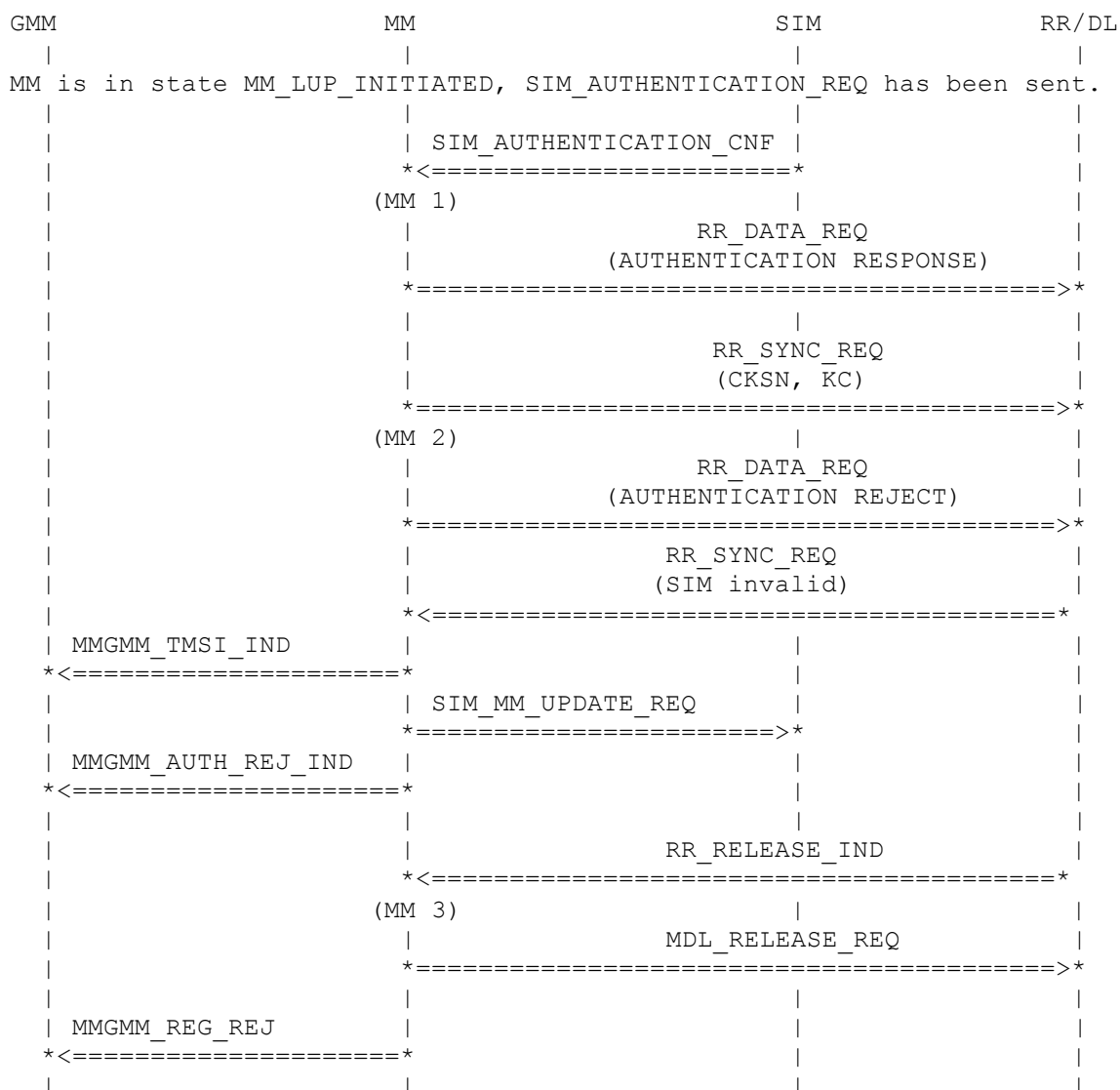
(MM 1)
The SIM processed the SRES. This is sent to the network. At the same time the SIM processed also the ciphering parameters CKSN and KC. RR will be informed about the new ciphering parameters.
(MM 2)
The signed response (SRES) calculated in the SIM and the signed response calculated in the network differed, therefore the authentication is rejected by the network. The registration data is deleted on the SIM, subsequently the SIM has been considered as invalid by the mobile station and RR and GMM are informed about this.
(MM 3)
RR sends RR_RELEASE_IND after the circuit switched connection has been released. MM resets the layer 2 and informs GMM with MMGMM_REG_REJ that the remote controlled MM update procedure has failed finally and that now all circuit switched activities related to this procedure are finished.

14.4 MM receives #2 in remote controlled location updating procedure

```
GMM                      MM                        SIM                  RR/DL
```
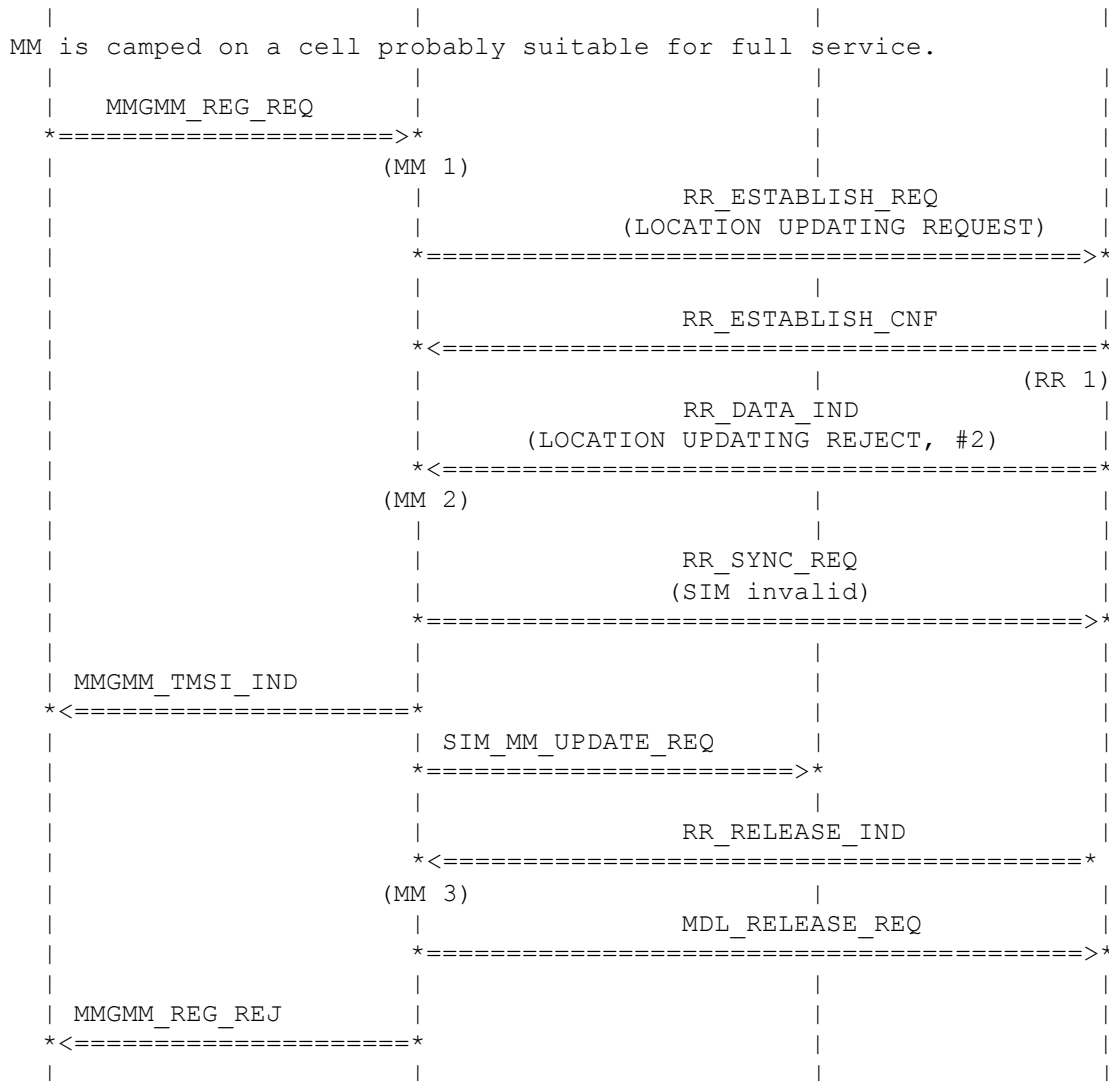
```
   |                      |                      |                      |
MM is camped on a cell probably suitable for full service.
   |                      |                      |                      |
   |    MMGMM_REG_REQ      |                      |                      |
 *=====================>*                      |                      |
   |                      (MM 1)                 |                      |
   |                      |          RR_ESTABLISH_REQ                   |
   |                      |      (LOCATION UPDATING REQUEST)            |
   |                      *==========================================>*
   |                      |                      |                      |
   |                      |          RR_ESTABLISH_CNF                   |
   |                      *<==========================================*
   |                      |                      |             (RR 1)   |
   |                      |          RR_DATA_IND                        |
   |                      |    (LOCATION UPDATING REJECT, #2)           |
   |                      *<==========================================*
   |                      (MM 2)                 |                      |
   |                      |                      |                      |
   |                      |          RR_SYNC_REQ                        |
   |                      |          (SIM invalid)                      |
   |                      *==========================================>*
   |                      |                      |                      |
   | MMGMM_TMSI_IND       |                      |                      |
 *<=====================*                      |                      |
   |                      | SIM_MM_UPDATE_REQ    |                      |
   |                      *=====================>*                      |
   |                      |                      |                      |
   |                      |          RR_RELEASE_IND                     |
   |                      *<==========================================*
   |                      (MM 3)                 |                      |
   |                      |          MDL_RELEASE_REQ                    |
   |                      *==========================================>*
   |                      |                      |                      |
   | MMGMM_REG_REJ        |                      |                      |
 *<=====================*                      |                      |
   |                      |                      |                      |
```

(MM 1)
GMM requires an update on the cell by MM's own procedures.
(RR 1)
MM establishes for location updating. The establishment is successful.
(MM 2)
The network cannot find the IMSI in the HLR. A location updating reject with cause #2, "IMSI unknown in HLR" is sent to the mobile station. The SIM has to be considered as invalid. RR is informed about that.
(MM 3)
The layer 2 connection has been released. MM resets layer 2 and informs GMM about the non-successful end of the remote controlled location updating procedure.

14.5 Combined attach in network mode I
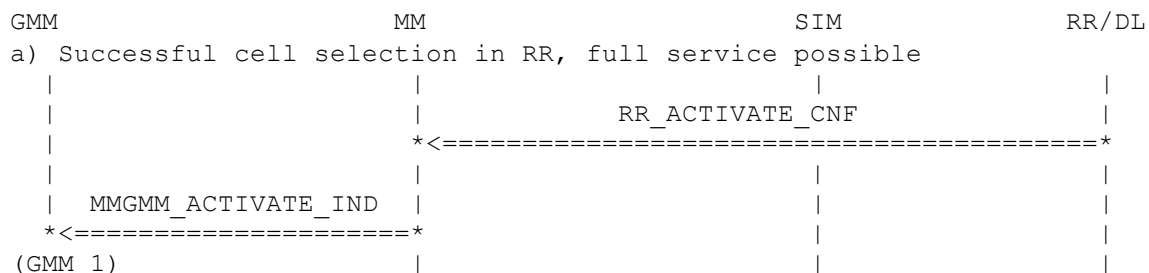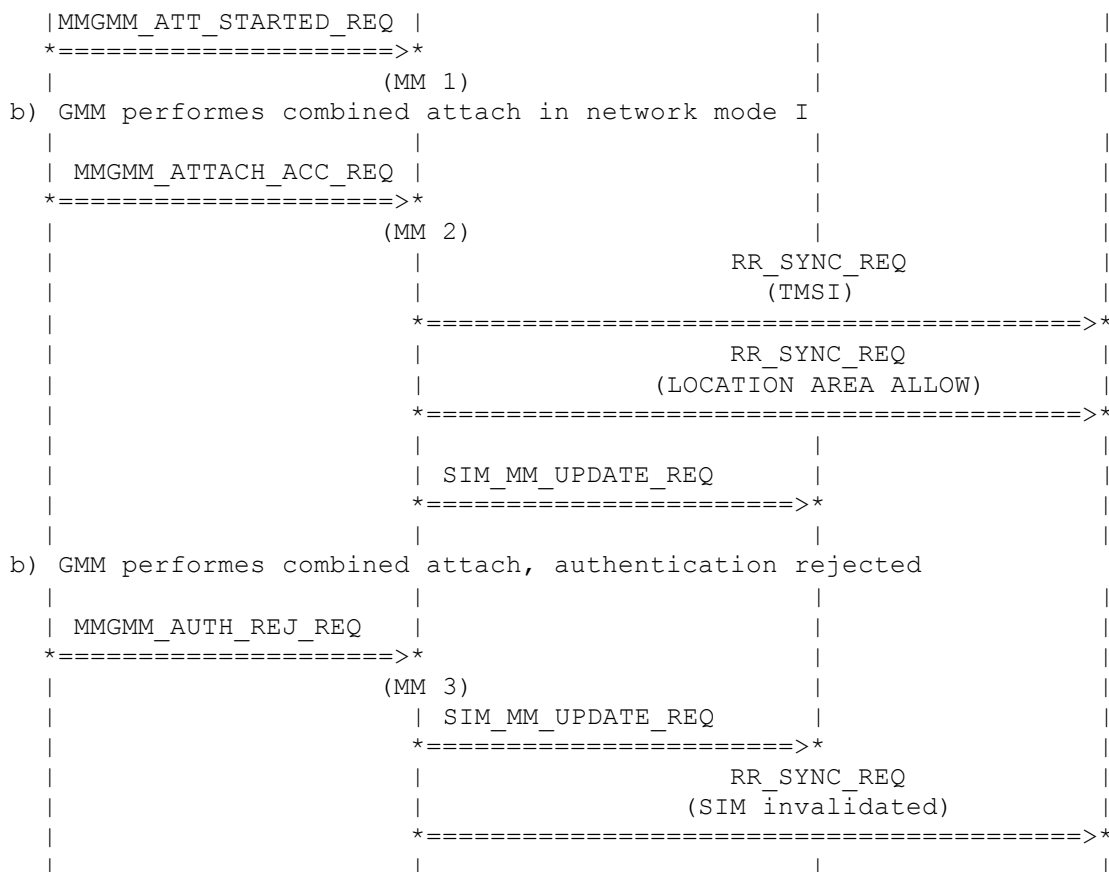
```
GMM                        MM                        SIM                    RR/DL
a) Successful cell selection in RR, full service possible
   |                      |                      |                      |
   |                      |          RR_ACTIVATE_CNF                    |
   |                      *<==========================================*
   |                      |                      |                      |
   |   MMGMM_ACTIVATE_IND  |                      |                      |
 *<=====================*                      |                      |
(GMM 1)                    |                      |                      |
```

```
 |MMGMM_ATT_STARTED_REQ |                                  |                  |
  *=====================>*                                 |                  |
 |                     (MM 1)                              |                  |
b) GMM performes combined attach in network mode I
 |                      |                                  |                  |
 | MMGMM_ATTACH_ACC_REQ |                                  |                  |
  *=====================>*                                 |                  |
 |                     (MM 2)                              |                  |
 |                      |                     RR_SYNC_REQ  |                  |
 |                      |                        (TMSI)    |                  |
 |                      *========================================>*
 |                      |                     RR_SYNC_REQ  |                  |
 |                      |                  (LOCATION AREA ALLOW) |             |
 |                      *========================================>*
 |                      |                                  |                  |
 |                      | SIM_MM_UPDATE_REQ                |                  |
 |                      *=====================>*           |                  |
 |                      |                                  |                  |
b) GMM performes combined attach, authentication rejected
 |                      |                                  |                  |
 | MMGMM_AUTH_REJ_REQ   |                                  |                  |
  *=====================>*                                 |                  |
 |                     (MM 3)                              |                  |
 |                      | SIM_MM_UPDATE_REQ                |                  |
 |                      *=====================>*           |                  |
 |                      |                     RR_SYNC_REQ  |                  |
 |                      |                   (SIM invalidated) |               |
 |                      *========================================>*
 |                      |                                  |                  |
```

(GMM 1)
A cell has selected which may be able to serve for full service. MM is waiting for the update decision from GMM.

(MM 1)
MM is informed by GMM that a combined attach procedure has been started.

(MM 2)
After suceessful cell selection, GMM analyzed the cell parameters and came to the conclusion that the cell offered network mode I. Network mode I allows a combined attach for GPRS+GSM in one step. GMM informs MM about the successful combined attach and subsequently MM informs RR and SIM about the new registered location area and the new TMSI. GPRS and GSM are in full service now. No confirmation towards GMM is needed here.

(MM 3)
After having performed step a), the network indicated an authentication failure. MM is informed about this fact. The SIM is considered as invalid until power cycle or equivalent procedure.

14.6 Non-combined successful attach
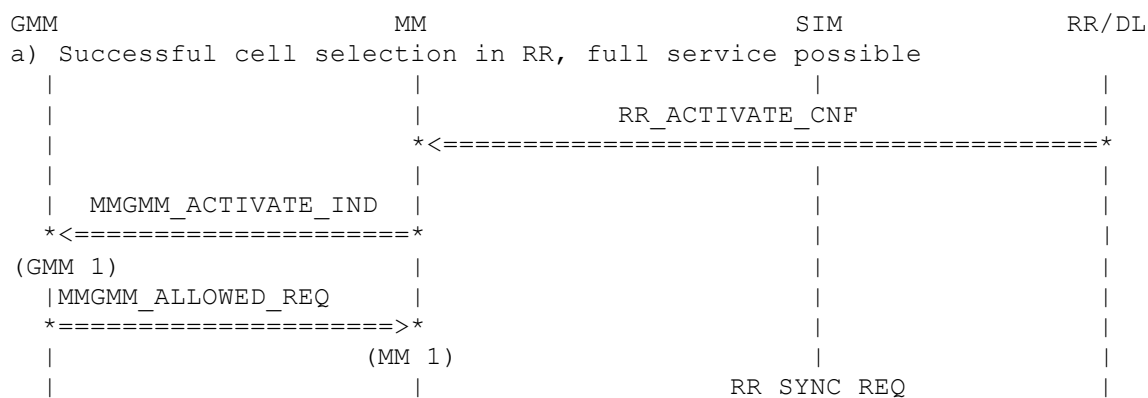
```
GMM                          MM                       SIM              RR/DL
a) Successful cell selection in RR, full service possible
 |                      |                                  |                  |
 |                      |               RR_ACTIVATE_CNF    |                  |
 |                      *<========================================*
 |                      |                                  |                  |
 | MMGMM_ACTIVATE_IND   |                                  |                  |
  *<=====================*                                 |                  |
(GMM 1)                 |                                  |                  |
 |MMGMM_ALLOWED_REQ     |                                  |                  |
  *=====================>*                                 |                  |
 |                     (MM 1)                              |                  |
 |                      |                     RR_SYNC_REQ  |                  |
```

```
     |                       |            (location area allowed)          |
     |                       *===========================================>*
     |                       | SIM_MM_UPDATE_REQ      |                    |
     |                       *======================>*                     |
     |                       |                        |                    |
```

(GMM 1)
A cell has selected which may be able to serve for full service. MM is waiting for the update decision
from GMM.
(MM 1)
MM is informed that GMM performed a successful non-combined attach procedure. MM informs RR
that the location area has to be removed from all forbidden lists, it is checked whether the PLMN on
which the non-combined procedure succeeded was forbidden, if so, it is to be removed from all PLMN
forbidden lists in MM and the SIM entity is brought in sync with MM.

14.7 A new cell is selected

It is assumed that a valid SIM is inserted into the mobile station.

```
GMM                           MM                            SIM               RR/DL
     |                          |            RR_ACTIVATE_IND                    |
     |                          *<============================================*
     |                         (MM 1)                        |                  |
     |                          |                            |                  |
a) No update needed
    |   MMGMM_ACTIVATE_IND    |                             |                  |
   *<=====================*                                  |                  |
(GMM 1)                    |                                 |                  |
b) Update needed after cell selection, MM's own procedures
    |                      |                                 |                  |
    |   MMGMM_ACTIVATE_IND  |                                |                  |
   *<=====================*                                  |                  |
(GMM 2)                    |                                 |                  |
    | MMGMM_REG_REQ        |                                 |                  |
    | (REMOTE_CONTROLLED)  |                                 |                  |
   *======================>*                                 |                  |
    |                      (MM 2)                             |                  |
    |                      |            RR_ESTABLISH_REQ                      |
    |                      |        (LOCATION UPDATING REQUEST)              |
    |                      *===========================================>*
    |                      |                                 |                  |
b) Update needed after cell selection, GMM's combined procedures
    |                      |                                 |                  |
    |   MMGMM_ACTIVATE_IND  |                                |                  |
   *<=====================*                                  |                  |
(GMM 3)                    |                                 |                  |
    |MMGMM_ATT_STARTED_REQ |                                 |                  |
   *======================>*                                 |                  |
    |                      (MM 2)                             |                  |
    |MMGMM_ATTACH_ACC_REQ  |                                 |                  |
   *======================>*                                 |                  |
    |                      (MM 3)                             |                  |
    |                      |            RR_SYNC_REQ                           |
    |                      |               (TMSI)                            |
    |                      *===========================================>*
    |                      |                                 |                  |
    |                      |            RR_SYNC_REQ                           |
    |                      |        (LOCATION AREA ALLOW)                     |
    |                      *===========================================>*
    |                      |                                 |                  |
    |                      | SIM_MM_UPDATE_REQ      |                          |
    |                      *======================>*                           |
```

```
      |                            |                            |                            |
```

(MM 1)

MM is informed by RR that a new cell has been selected.

(GMM 1)

GMM receives the indication that a new cell has been selected by RR. No update is needed for GSM on the cell. The next state is IDLE, NORMAL SERVICE.

(GMM 2)

GMM receives the indication that a new cell has been selected by RR. To obtain fulll service for GSM, an update is needed.

(MM 2)

The network mode is different from I, no combined attach. An update by MM's own procedures is started.

(GMM 3)

GMM receives the indication that a new cell has been selected by RR. To obtain fulll service for GSM, an update is needed.

(MM 2)

The cell is a cell allowing combined attach in network mode I. MM is informed about the start of the combined attach procedure.

(MM 3)

MM becomes IDLE updated by a successful GPRS combined attach procedure. RR and SIM are informed.

14.8 T2312 expired

T3212 expired, a periodic update may be needed now. MM notifies GMM about this event. GMM decides whether the update is performed by MM's own procedures.

```
GMM                           MM                        SIM                   RR/DL
 |                         <T3212>                       |                     |
 | MMGMM_LUP_NEEDED_IND |                                |                     |
 *<====================*                                 |                     |
(GMM 1)                       |                          |                     |
 | MMGMM_REG_REQ       |                                 |                     |
 | (REMOTE_CONTROLLED) |                                 |                     |
 *====================>*                                 |                     |
 |                        (MM 1)                          |                     |
 |                         |          RR_ESTABLISH_REQ              |
 |                         |    (LOCATION UPDATING REQUEST)    |
 |                         *=======================================>*
 |                         |                              |                     |
```
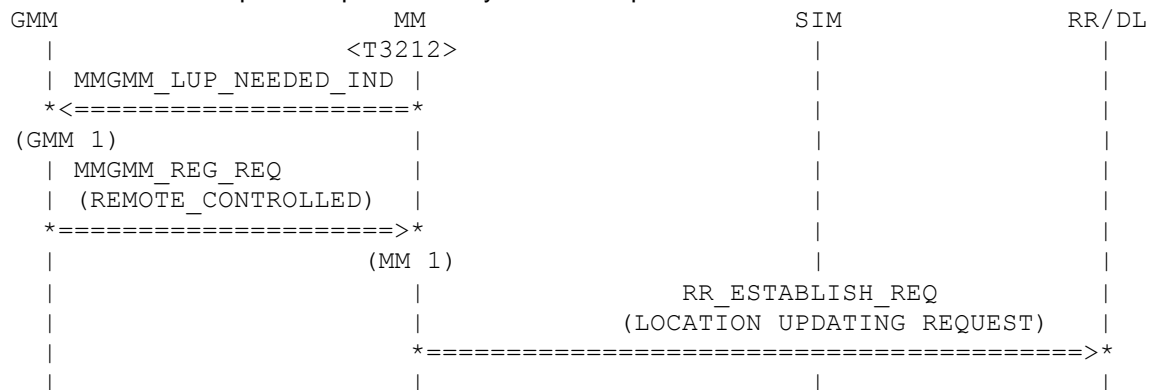
(GMM 1)
T3212 expired in MM. A cell is selected which is offering full service. GMM is notified about T3212 expiry.
(MM 1)
The cell is a cell not allowing the usage of combined procedures, network mode II or III, but not network mode I. GMM suspends the GPRS side and triggers a location updating by MM's own procedure.

14.9 RXLEVEL jump

MM is in state IDLE, ATTEMPTING TO UPDATE after 4 missed location updating attempts. A normal SIM is inserted.

```
GMM                           MM                        SIM                   RR/DL
 |                           |               RR_SYNC_IND             |
 |                           |            (Better RX level)          |
 |                           *<=======================================*
 |                        (MM 1)                          |                     |
 | MMGMM_LUP_NEEDED_IND |                                |                     |
 *<====================*                                 |                     |
(GMM 1)                       |                          |                     |
 | MMGMM_REG_REQ       |                                 |                     |
 | (REMOTE_CONTROLLED) |                                 |                     |
 *====================>*                                 |                     |
 |                        (MM 1)                          |                     |
 |                         |          RR_ESTABLISH_REQ              |
 |                         |    (LOCATION UPDATING REQUEST)    |
 |                         *=======================================>*
 |                         |                              |                     |
```
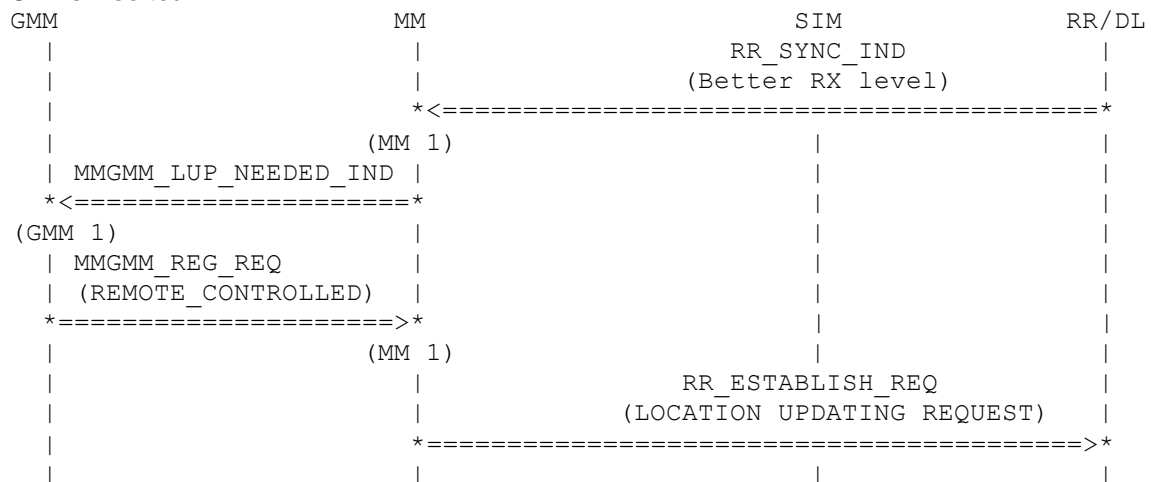
(MM 1)
MM received the indication from RR that the RX level has increased. MM is in state IDLE, ATTEMPTING TO UPDATEA after 4 missed updating attempts. GMM is informed about the improvement of the situation.
(GMM 1)
The network mode is different from I, GMM triggers an update attempt.

TEXAS INSTRUMENTS

SIM removal in IDLE, NORMAL SERVICE, GPRS active

```
GMM                           MM                        SIM              RR/DL
 |                            |                          |                 |
 |                            |    SIM_REMOVE_IND        |                 |
 |                            *<=======================* |                 |
 |                            |    (MM 1)                |                 |
 |   MMGMM_NREG_REQ           |                          |                 |
 *=======================>*   |                          |                 |
 |                            |    (MM 2)                |                 |
 |                            |                RR_ESTABLISH_REQ            |
 |                            |            (IMSI DETACH INDICATION)        |
 |                            *========================================>*  |
 |                            |                          |        (RR 1)   |
 |                            |              RR_ESTABLISH_CNF             |
 |                            *<========================================*  |
 |                            |    (MM 3)                |                 |
 |                            |               RR_RELEASE_IND              |
 |                            *<========================================*  |
 |                            |    (MM 4)                |                 |
 |                            |               MDL_RELEASE_REQ             |
 |                            *========================================>*  |
 |                            |                          |                 |
 |   MMGMM_NREG_CNF           |                          |                 |
 *<======================*    |                          |                 |
 |                            |                          |                 |
```
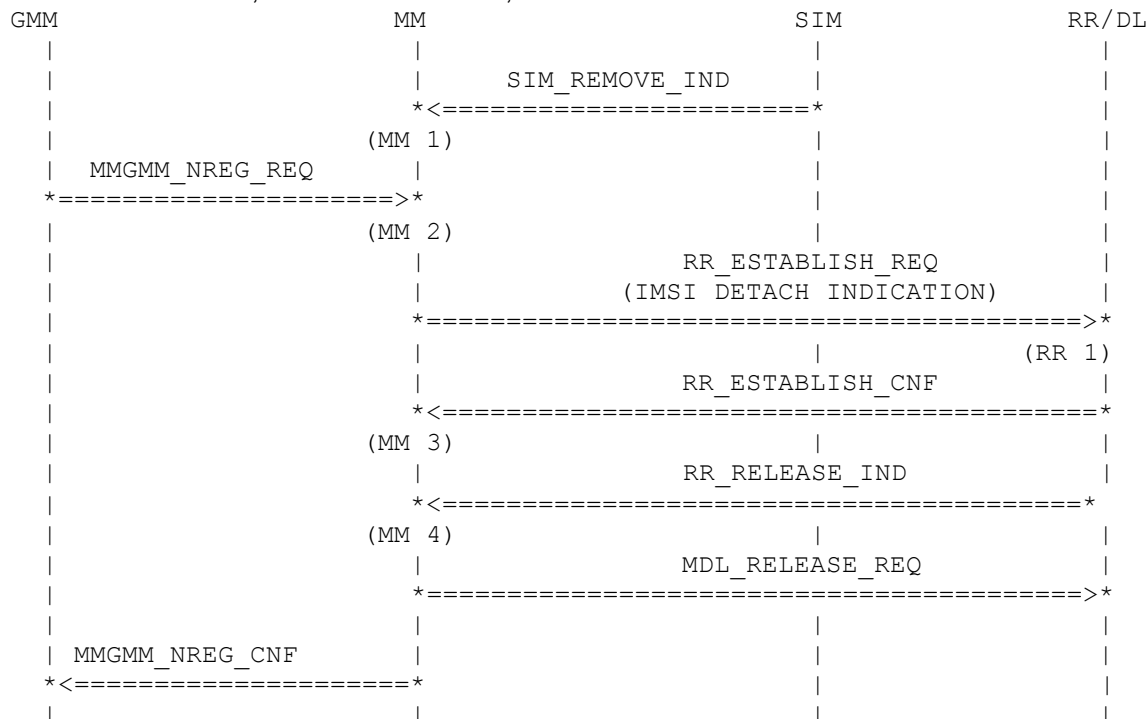
(MM 1)
MM receives a SIM_REMOVE_IND. The fact that the SIM was removed will be remembered internally by MM if GPRS is also present, but no for the outside visible actions will be performed now.

(MM 2)
GMM has also received an indication from the SIM that the SIM was removed physically. GMM requests the deregistration with a cause indicating that the SIM was removed.

(RR 1)
MM requests the establishment of a RR connection with a piggybacked IMSI DETACH INDICATION message.

(MM 3)
MM received confirmation from RR that the RR connection has been established. This means that the IMSI DETACH message has been received by the network.

(MM 4)
After CHANNEL RELEASE and the release of the layer 2 connection, RR indicates the release of all dedicated channels to the network. Layer 2 is reset and the negative registration request is confirmed to GMM.

14.10 The cell changed the value of T3212 on BCCH

The cell changed the value of T3212, the periodic location update timer, on the BCCH. The new value of this timer is forwarded to GMM.

```
GMM/CM                        MM                        SIM              RR/DL
 |                            |                          |                 |
 |                            |    (MM 1)                |                 |
 |                            |                  RR_SYNC_IND              |
 |                            |                (T3212 changed)            |
 |                            *<========================================*  |
 |                            |                          |                 |
 |   MMGMM_T3212_VAL_IND      |                          |                 |
 *<======================*    |                          |                 |
 |                            |                          |                 |
```
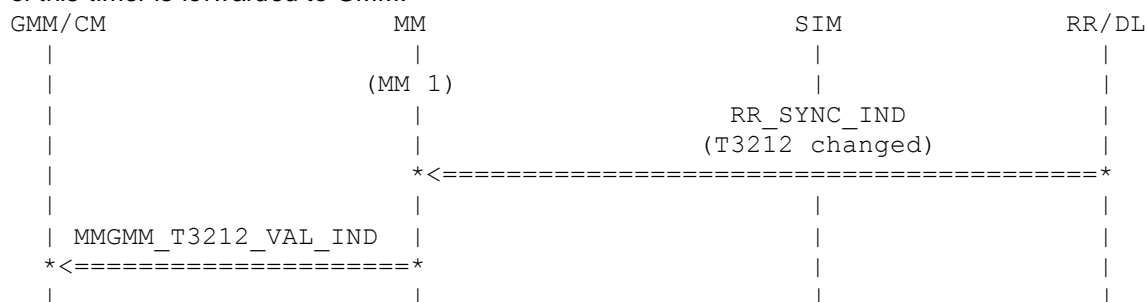
(MM 1)
RR detected that the value of T3212 has been changed for the serving cell. This information is forwarded to GMM.

15 Authentication, GPRS delivered with protocol stack

If the Authentication procedure fails, the GPRS side of the protocol stack has to be informed. This is
not only true if GPRS is activated by the mobile user, but always if GPRS has been delivered as part
of the protocol stack. Here it is assumed that GPRS is part of the protocol stack, but currently disabled
by the user.

```
GMM/CM                    MM                        SIM               RR/DL
  |                        |                         |                   |
  |                       (MM 1)                     |                   |
  |                        |        RR_ESTABLISH_REQ                     |
  |                        |     (LOCATION UPDATING REQUEST)             |
  |                        *=========================================>*
  |                        |                         |        (RR 1)    |
  |                        |        RR_ESTABLISH_CNF                     |
  |                        *<=========================================*
  |                        |                         |                   |
  |                       (MM 2)                     |                   |
  |                        |            RR_DATA_IND                      |
  |                        |       (AUTHENTICATION REQUEST)              |
  |                        *<=========================================*
  |                        | SIM_AUTHENTICATION_REQ |                   |
  |                        *=======================>*                   |
  |                        | SIM_AUTHENTICATION_CNF |                   |
  |                        *<=======================*                   |
  |                        |            RR_DATA_REQ                      |
  |                        |      (AUTHENTICATION RESPONSE)              |
  |                        *=========================================>*
  |                        |            RR_SYNC_REQ                      |
  |                        |        (ciphering parameters)               |
  |                        *=========================================>*
  |                        |            RR_DATA_IND                      |
  |                        |       (AUTHENTICATION REJECT)               |
  |                        *<=========================================*
  |                       (MM 3)                     |                   |
  |                        |            RR SYNC REQ                      |
  |                        |          (SIM invalid)                      |
  |                        *=========================================>*
  |                        |    SIM MM UPDATE REQ   |                   |
  |                        *<=======================*                   |
  | MMGMM_AUTH_REJ_IND     |                         |                   |
  *<=====================*                           |                   |
  |                        |                         |                   |
  |                       (MM 4)                     |                   |
  |                        |            RR_RELEASE_IND                   |
  |                        *<=========================================*
  |                        |                         |                   |
  |                        |            MDL_RELEASE_REQ                  |
  |                        *=========================================>*
  |                        |                         |                   |
  | MMGMM_NREG_IND         |                         |                   |
  *<=====================*                           |                   |
  |                        |                         |                   |
```

(MM 1)
For some reason (new location area, T3212 expired, switch on and IMSI ATTACH needed) MM estab-
lishes a RR connection for a circuit switched location updating procedure. GPRS is disabled and
therefore MM has full control.
(RR 1)
Establishment was successful, MM has a dedicated connection to the network.
(MM 2)
The network starts the ciphering procedure.

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(MM 3)
The authentication procedure did not succeed. The SIM has to be considered as invalid, not only for GSM, but also for GPRS. RR is informed about SIM invalidation, registration data on the SIM is deleted and the fact that the ciphering procedure failed is indicated to GMM by means of MMGMM_AUTH_REJ_IND.
(MM 4)
After release of the layer 2 connection, the MMI is informed via GMM about the limited service condition.

16 Call Handling while GPRS is active

Generally, MM is not allowed to establish any circuit switched RR connection without having negociated this with GMM. This is not only true for the MM specific procedures like LOCATION UPDATING and IMSI ATTACH, but also for the services MM provides for the CM entities. GMM has to be asked for allowance before the establishment is made for any CM entity and has to be informed if after the release of the layer 2 connection the circuit switched procedure is over so that the GPRS may be able to perform a switchover of some physical resources to the GPRS side of the protocol stack.

16.1 Call Handling, MO Call, GPRS is active, positive
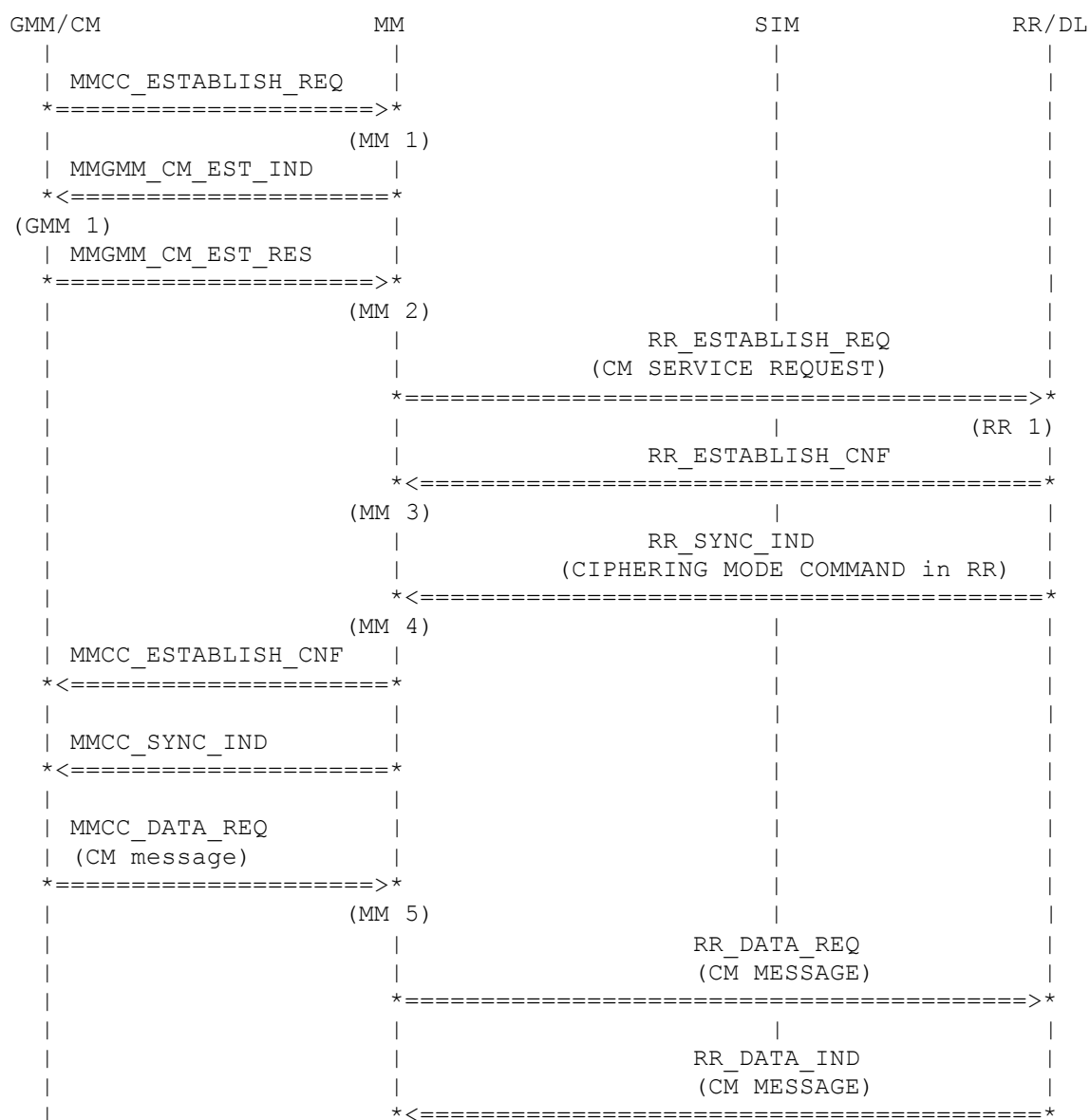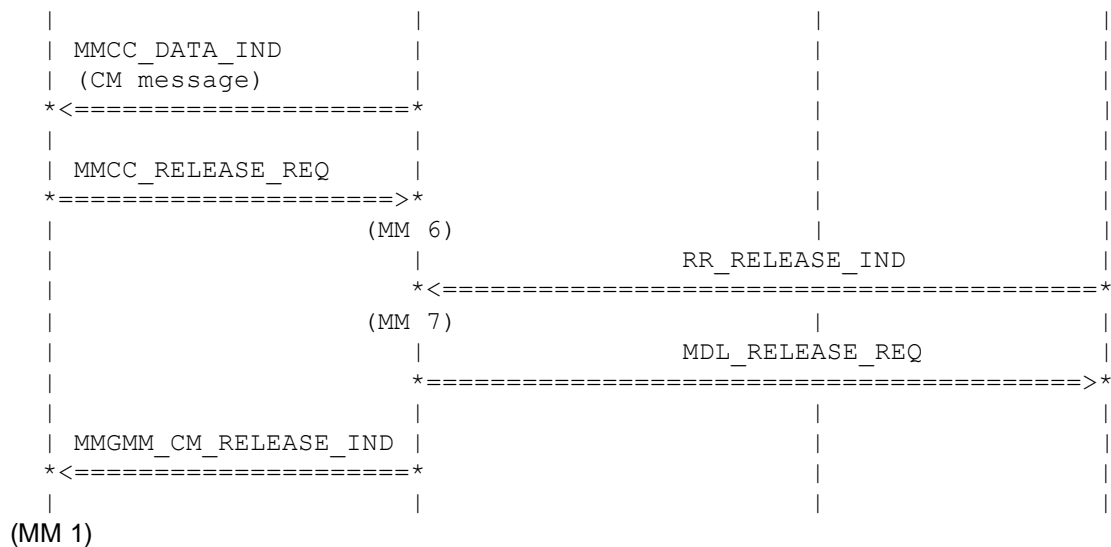
```
GMM/CM                      MM                        SIM                    RR/DL
 |                           |                         |                      |
 | MMCC_ESTABLISH_REQ        |                         |                      |
 *=====================>*    |                         |                      |
 |                      (MM 1)                         |                      |
 | MMGMM_CM_EST_IND         |                          |                      |
 *<=====================*    |                         |                      |
(GMM 1)                      |                         |                      |
 | MMGMM_CM_EST_RES         |                          |                      |
 *=====================>*    |                         |                      |
 |                      (MM 2)                         |                      |
 |                           |          RR_ESTABLISH_REQ                     |
 |                           |         (CM SERVICE REQUEST)                  |
 |                           *=========================================>*    |
 |                           |                         |              (RR 1)  |
 |                           |          RR_ESTABLISH_CNF                     |
 |                           *<=========================================*    |
 |                      (MM 3)                         |                      |
 |                           |            RR_SYNC_IND                        |
 |                           |    (CIPHERING MODE COMMAND in RR)             |
 |                           *<=========================================*    |
 |                      (MM 4)                         |                      |
 | MMCC_ESTABLISH_CNF        |                         |                      |
 *<=====================*    |                         |                      |
 |                           |                         |                      |
 | MMCC_SYNC_IND             |                         |                      |
 *<=====================*    |                         |                      |
 |                           |                         |                      |
 | MMCC_DATA_REQ             |                         |                      |
 | (CM message)             |                          |                      |
 *=====================>*    |                         |                      |
 |                      (MM 5)                         |                      |
 |                           |             RR_DATA_REQ                       |
 |                           |            (CM MESSAGE)                       |
 |                           *=========================================>*    |
 |                           |                         |                      |
 |                           |             RR_DATA_IND                       |
 |                           |            (CM MESSAGE)                       |
 |                           *<=========================================*    |
 |                           |                         |                      |
```

```
|                        |                          |                          |
|  MMCC_DATA_IND         |                          |                          |
|  (CM message)          |                          |                          |
*<=====================* |                          |                          |
|                        |                          |                          |
|  MMCC_RELEASE_REQ      |                          |                          |
*=====================>* |                          |                          |
|                   (MM 6)                           |                          |
|                        |              RR_RELEASE_IND                          |
|                        *<=========================================*          |
|                   (MM 7)                           |                          |
|                        |              MDL_RELEASE_REQ                         |
|                        *=========================================>*          |
|                        |                          |                          |
|  MMGMM_CM_RELEASE_IND  |                          |                          |
*<=====================* |                          |                          |
|                        |                          |                          |
```

(MM 1)
MM is in IDLE, NORMAL SERVICE state. GPRS is active. MM receives the request from a CM entity to establish for CM service.
(GMM 1)
GMM is informed about the wish to establish for circuit switched CM service.
(MM 2)
GMM's response is positive, MM is allowed to establish for CM service.
(RR 1)
RR receives a request to establish a RR connection, the CM SERVICE REQUEST message is piggy-backed with the request.
(MM 3)
RR confirms the establishment of a RR connection.
(MM 4)
The network switches on ciphering. This is regarded in MM as substitute for a CM SERVICE ACCEPT message. The establish request from the CM entity is confirmed by MM, subsequently the CM entity is informed about the new ciphering mode.
(MM 5)
The CM entity exchanges some messages with the network via the established MM connection.
(MM 6)
The CM entity requests the release of the MM connection. As there is now no MM connection active anymore, MM enters the state WAIT FOR NETWORK COMMAND.
(MM 7)
RR indicates the release of the layer 2 connection. GMM is informed by MM about the end of the circuit switched procedure. GMM may want to switch the physical resources over to GPRS now.

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16.2 Call Handling, MO Call, GPRS is active, negative

```
GMM/CM                        MM                        SIM              RR/DL
  |                           |                          |                 |
  | MMCC_ESTABLISH_REQ        |                          |                 |
  *=====================>*                               |                 |
  |                    (MM 1)                             |                 |
  | MMGMM_CM_EST_IND          |                          |                 |
  *<====================*                                |                 |
(GMM 1)                       |                          |                 |
  | MMGMM_CM_EST_RES          |                          |                 |
  *=====================>*                               |                 |
  |                    (MM 2)                             |                 |
  | MMCC_RELEASE_IND          |                          |                 |
  *<====================*                                |                 |
(CM 1)                        |                          |                 |
  |                           |                          |                 |
```

(MM 1)

MM is in IDLE, NORMAL SERVICE state. GPRS is active. MM receives the request from a CM entity to establish for CM service.

(GMM 1)

GMM is informed about the wish to establish for circuit switched CM service.
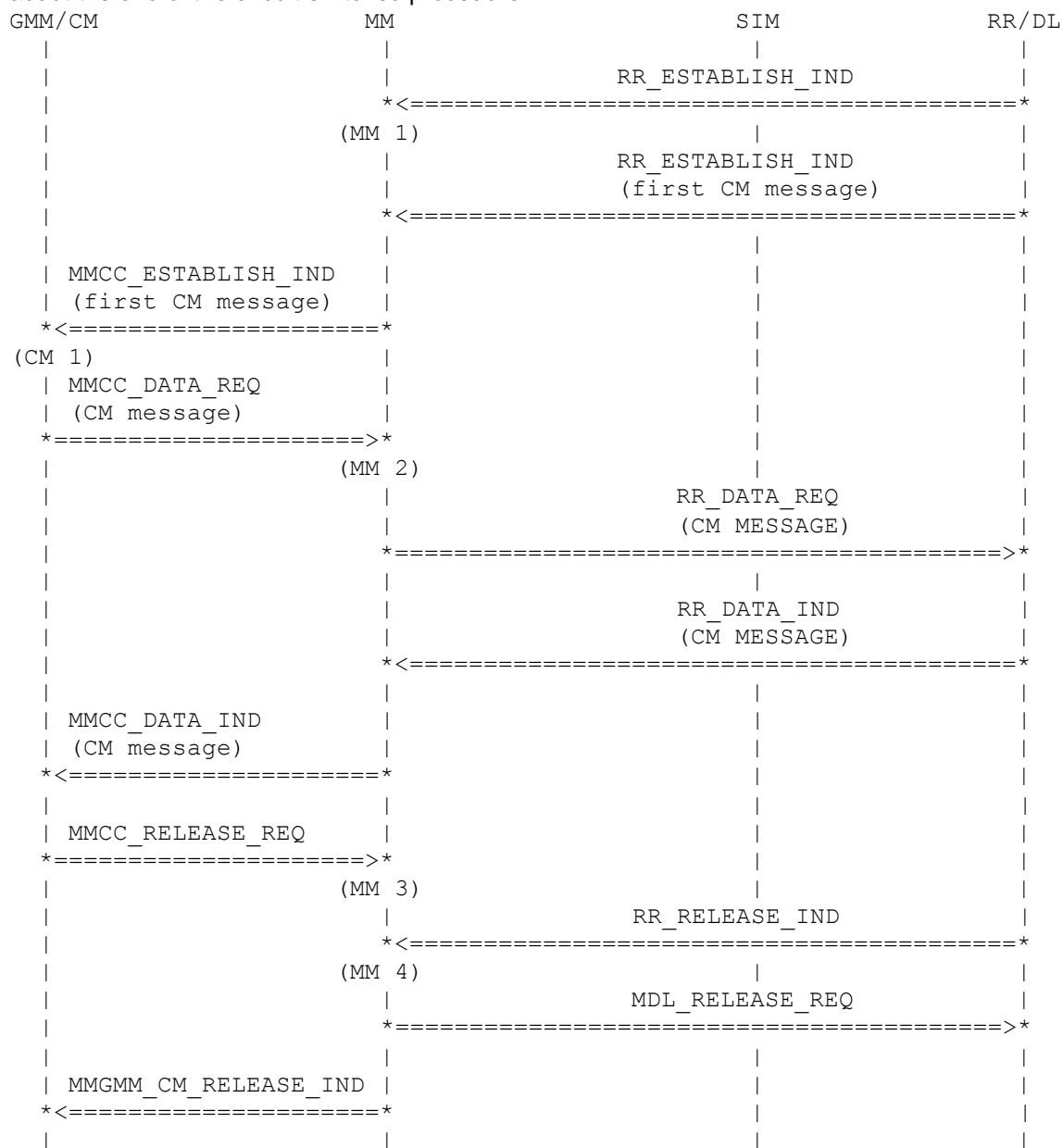
(MM 2)

MM receives the response from GMM about the establishment of circuit switched operation. The response is negative.

(CM 1)

The CM entity which requested the service receives a release indication. The procedure is over.

16.3 Call Handling, MT Call, GPRS is active

A mobile terminated call is performed. Unlike in the MO case, before the MT call GMM can not be informed by MM that a circuit switched procedure is ongoing. In the MT case this is the task of GRR. If MM receives the indication of successful establishment, it is implicitly clear for MM that circuit switched services for CM are allowed until the layer 2 connection is released and GMM is informed by MM about the end of the circuit switched procedure.

```
GMM/CM                         MM                        SIM             RR/DL
  |                            |                          |                |
  |                            |            RR_ESTABLISH_IND               |
  |                           *<========================================*
  |                         (MM 1)                        |                |
  |                            |            RR_ESTABLISH_IND               |
  |                            |            (first CM message)             |
  |                           *<========================================*
  |                            |                          |                |
  | MMCC_ESTABLISH_IND         |                          |                |
  | (first CM message)         |                          |                |
 *<====================*                                  |                |
(CM 1)                         |                          |                |
  | MMCC_DATA_REQ              |                          |                |
  | (CM message)               |                          |                |
 *====================>*                                  |                |
  |                         (MM 2)                        |                |
  |                            |            RR_DATA_REQ                     |
  |                            |            (CM MESSAGE)                    |
  |                           *========================================>*
  |                            |                          |                |
  |                            |            RR_DATA_IND                     |
  |                            |            (CM MESSAGE)                    |
  |                           *<========================================*
  |                            |                          |                |
  | MMCC_DATA_IND              |                          |                |
  | (CM message)               |                          |                |
 *<====================*                                  |                |
  |                            |                          |                |
  | MMCC_RELEASE_REQ           |                          |                |
 *====================>*                                  |                |
  |                         (MM 3)                        |                |
  |                            |            RR_RELEASE_IND                  |
  |                           *<========================================*
  |                         (MM 4)                        |                |
  |                            |            MDL_RELEASE_REQ                 |
  |                           *========================================>*
  |                            |                          |                |
  | MMGMM_CM_RELEASE_IND       |                          |                |
 *<====================*                                  |                |
  |                            |                          |                |
```

(MM 1)
MM receives an establish indication from RR in IDLE state and enters state WAIT FOR NETWORK COMMAND. GPRS is active. By receiving the establish indication from RR which starts a circuit switched service for CM it is implicitely clear that GMM is informed about the ongoing circuit switched procedure. The CM establishment state in MM changes accordingly to reflect this.
(CM 1)
By receiving the first CM message from the network, MM state changes from WAIT FOR NETWORK COMMAND to CONNECTION ACTIVE. The respective transaction is marked as active now also. The respective CM entity changes its state for the respective transaction from IDLE to non-IDLE.
(MM 2)

CM messages are exchanged via the existing MM connection.
(MM 3)
The MM connection is released by the CM entity. As there are no other ongoing CM connections on-going, MM reenters state WAIT FOR NETWORK COMMAND.
(MM 4)
The RR connection is released after release of the layer 2 connection. MM resets layer 2 and informs GMM about the end of the circuit switched procedure.

16.4 Call Handling, MT Call, Failed before layer 2 connection could be established

A mobile terminated call is performed. But here the MT call failed before the establishment of the L2 connection could be finished, eg. random access failure. In this cases, MM receives an unsolicited RR_RELEASE_IND which is forwarded as MMGMM_CM_RELEASE_IND to GMM.

```
GMM/CM                          MM                      SIM                     RR/DL
MM is in IDLE state
  |                              |                RR_RELEASE_IND                  |
  |                              *<=======================================*
  |                            (MM 1)                     |                       |
  |                              |                MDL_RELEASE_REQ                 |
  |                              *=======================================>*
  |                              |                        |                       |
  | MMGMM_CM_RELEASE_IND         |                        |                       |
  *<====================*        |                        |                       |
  |                              |                        |                       |
```
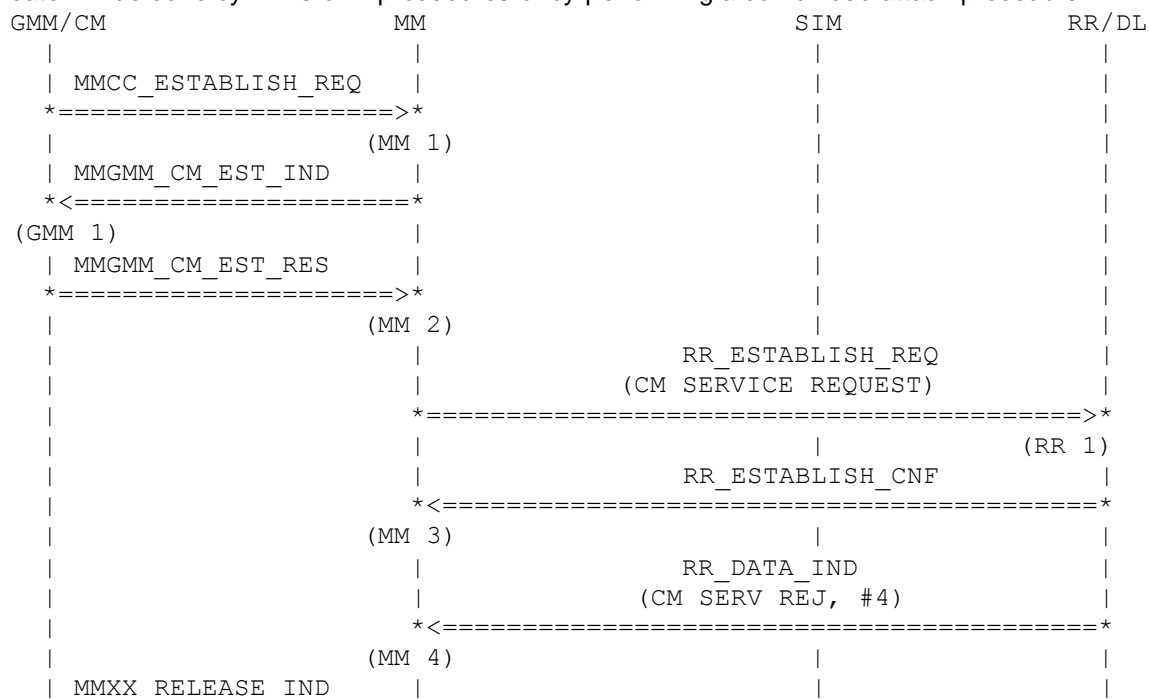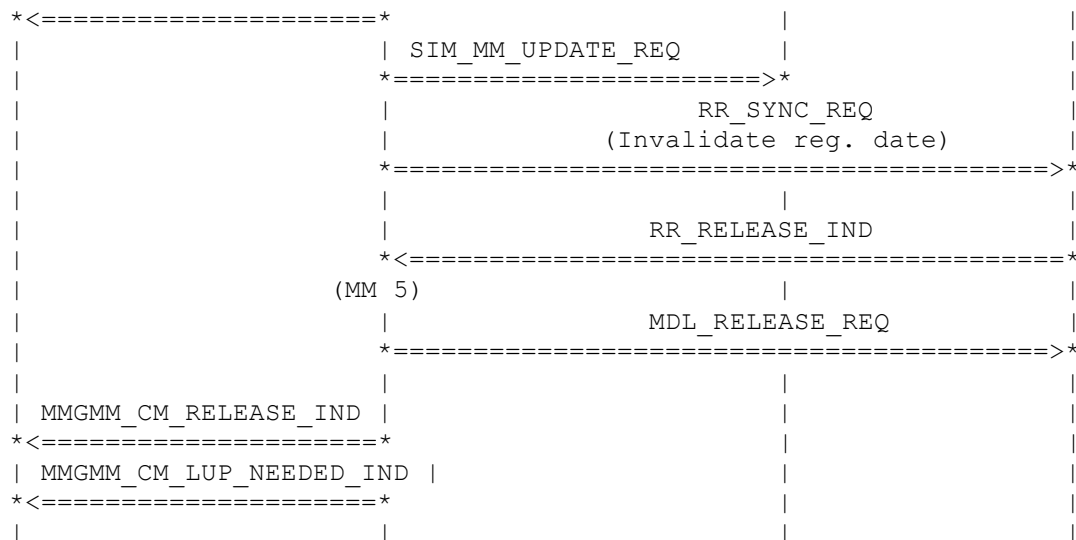
(MM 1)
MM receives a RR_RELEASE_IND while in IDLE state without having an established layer 2 connection or having sent any request to establish such a connection. After resetting the layer 2, MM informs GMM that any circuit switched operation has ended.

16.5 Call Handling, IMSI unknown in VLR

A mobile originated call is performed. The IMSI is unknown in VLR. MM releases the call towards the MMI and indicates the immediate need for a location update to GMM. GMM decides whether the update will be done by MM's own procedures or by performing a combinded attach procedure.

```
GMM/CM                          MM                      SIM                     RR/DL
  |                              |                        |                       |
  | MMCC_ESTABLISH_REQ           |                        |                       |
  *====================>*        |                        |                       |
  |                            (MM 1)                      |                       |
  | MMGMM_CM_EST_IND             |                        |                       |
  *<====================*        |                        |                       |
(GMM 1)                          |                        |                       |
  | MMGMM_CM_EST_RES             |                        |                       |
  *====================>*        |                        |                       |
  |                            (MM 2)                      |                       |
  |                              |                RR_ESTABLISH_REQ                |
  |                              |               (CM SERVICE REQUEST)             |
  |                              *=======================================>*
  |                              |                        |                    (RR 1)
  |                              |                RR_ESTABLISH_CNF               |
  |                              *<=======================================*
  |                            (MM 3)                      |                       |
  |                              |                  RR_DATA_IND                   |
  |                              |               (CM SERV REJ, #4)                |
  |                              *<=======================================*
  |                            (MM 4)                      |                       |
  | MMXX_RELEASE_IND             |                        |                       |
```

```
 *<====================*                |                     |
  |                     | SIM_MM_UPDATE_REQ      |                     |
  |                     *=======================>*                     |
  |                     |                        RR_SYNC_REQ           |
  |                     |                   (Invalidate reg. date)     |
  |                     *==========================================>*
  |                     |                        |                     |
  |                     |                        RR_RELEASE_IND        |
  |                     *<==========================================*
  |                 (MM 5)                        |                     |
  |                     |                        MDL_RELEASE_REQ       |
  |                     *==========================================>*
  |                     |                        |                     |
  | MMGMM_CM_RELEASE_IND |                       |                     |
  *<====================*                        |                     |
  | MMGMM_CM_LUP_NEEDED_IND |                    |                     |
  *<====================*                        |                     |
  |                     |                        |                     |
```

(MM 1)
MM is in IDLE, NORMAL SERVICE state. GPRS is active. MM receives the request from a CM entity to establish for CM service.
(GMM 1)
GMM is informed about the wish to establish for circuit switched CM service.
(MM 2)
GMM's response is positive, MM is allowed to establish for CM service.
(RR 1)
RR receives a request to establish a RR connection, the CM SERVICE REQUEST message is piggy-backed with the request.
(MM 3)
RR confirms the establishment of a RR connection.
(MM 4)
The network rejects the CM SERVICE REQUEST with cause #4, "IMSI unknown in VLR". Registration has been lost. The pending call is released towards the MMI, the SIM and RR are informed about the loss of registration.
(MM 5)
The layer 2 connection has been released. MM resets layer 2. GMM is informed about the release of the circuit switched layer 2 connection to the network, subsequently the need for an immediate update is indicated to GMM. GMM decides, depending on the network mode, whether this has to be done via MM's own procedures or by a combined attach.

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Appendices

A.   Acronyms

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

B.   Glossary

**International Mobile Tel-
ecommunication 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/>