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1. INTRODUCTION

In GERAN *Iu mode* the RRC layer represents the layer 3 control plane protocol for radio resource management.
The MS operating in *Iu mode* represents the mode of operation of the MS when connected to the Core Network via GERAN or UTRAN and the Iu interface.
The MS operating in GERAN *Iu mode* represents the mode of operation of the MS when connected to the Core Network via GERAN and the Iu interface. As a result of harmonization between UTRAN and GERAN, the GERAN RRC protocol is based on UTRAN RRC. At high level the GERAN *Iu mode* RRC connected state is similar with UTRAN RRC connected state.
GERAN *Iu mode* RRC inherited from UTRAN principles like:

- Establishment and release of the Resources;
- Radio Bearer control;
- Integrity protection. The security algorithms are adopted from UTRAN, most of the RRC messages being integrity protected.
- MS capability request.
- Some of the GERAN RRC principles are based on GSM Radio Resource (RR) like: Measurement reporting, system broadcast, handover procedures.

The specification of the RRC GERAN *Iu mode* stage 2 for rel 5 is in 3GPP TS 43.051 (Radio Access Network- Overall description - Stage 2). The emphasis of this document should be placed on the RRC GERAN *Iu mode* stage 2 description (43.051) and RRC GERAN *Iu mode* stage 3 specifications described in 3GPP TS 44.118.
All procedures and protocols are defined in GERAN *Iu mode* Stage 2 overall description and the appropriate L3 specification. A summary of the procedures and the protocols are presented briefly in the present document.

It is recommended to use this document and references mentioned within this text as guidance when developing the GERAN *Iu mode* RRC Test cases in GERAN WG4/5.

2. DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

- **A/Gb mode**: mode of operation of the MS when connected to the Core Network via GERAN and the A and/or Gb interfaces.
- **Access Stratum (AS):** defined in 3GPP TS 23.101.
- **Non Access Stratum (NAS)**: defined in 3GPP TS 21.905.
- **RR idle:** defined in 3GPP TS 44.018.
- **Iu mode**: mode of operation of the MS when connected to the Core Network via GERAN or UTRAN and the Iu interface.
- **RR**: Radio Resource control plane protocol for radio resource management that is used when a mobile station is operating in *A/Gb mode*.
- **RRC**: Radio Resource control plane protocol for radio resource management that is used when a mobile station is operating in *Iu mode*.
- **RRC Connection**: A point-to-point bi-directional connection between RRC peer entities in the MS and the GERAN characterised by the allocation of a G-RNTI. An MS has either zero or one RRC connection.
- **RRC-Idle mode**: In RRC-Idle mode, the MS has no established RRC connection.
- **RRC-Connected mode**: In RRC-Connected mode, the MS has an established RRC connection.
- **Inter-RAT handover** indicates the transfer of the connection, under the control of the network, between the MS and two different radio access technologies (e.g. UMTS to GERAN *Iu mode*).
- **Inter-mode handover** indicates the transfer of the connection, under the control of the network, between the MS and GERAN *Iu mode* to/from GERAN *A/Gb mode*.

- **Mobile Station:** the mobile station (MS) consists of Mobile or User Equipment (ME or MS) with a valid SIM or USIM attached.
- **RR group receive mode**: defined in 3GPP TS 44.018.
- **RR dedicated mode**: defined in 3GPP TS 44.018.
- **RR group transmit mode**: defined in 3GPP TS 44.018.
- **RR packet idle mode**: defined in 3GPP TS 44.018.
- **RR packet transfer mode**: defined in 3GPP TS 44.018.
- **RR dual transfer mode**: defined in 3GPP TS 44.018.
- "**Channel set"** is used to identify TCHs that carry related user information flows, e.g., in a multislot configuration used to support circuit switched connection(s), which therefore need to be handled together.
- **Temporary block flow (TBF)** is defined in 3GPP TS 44.060.
- **RLC/MAC block**: A RLC/MAC block is the protocol data unit exchanged between RLC/MAC entities, see 3GPP TS 44.060.
- The **network modes of operation** for GERAN *Iu mode* are:

NMO I: the network has a Gs interface. The network sends CS paging and PS paging messages for an attached MS via the SGSN and the Iu-ps interface to GERAN Iu. Paging co-ordination is achieved at the SGSN thanks to the Gs interface. GERAN Iu pages the MS on PACCH if available, else PCCCH. MS can initiate combined procedures according to its capabilities.

NMO II: the network has no Gs interface. For an attached MS, the network sends CS paging messages, via the MSC plus the Iu-cs interface, and sends PS paging messages, via the SGSN plus the Iu-ps interface to GERAN Iu. GERAN Iu performs paging co-ordination and pages the MS on PACCH if available, else PCCCH. MSs cannot initiate combined procedures.

In A/Gb mode the network mode of operation are described in 3GPP TS 23.060, section 6.4.3.1 as follows:
The network operation mode is used to indicate whether the Gs interface is installed or not. When the Gs interface is present, MSs initiate combined procedures.

Table 3: Network Operation Modes for Iu mode

Mode	Network configuration	Combined procedure by MT
I	Gs interface is present	Yes
II	Gs interface is not present	No

The network operation mode (mode I or II) shall be indicated as system information to the MSs. For proper operation, the mode of operation should be the same in each cell of a routeing area.
Based on the mode of operation provided by the network, the MS derives whether to initiate combined update procedures or separate update procedures.
Network operation modes I and II for Iu mode correspond to modes I and II for A/Gb mode, respectively. Mode III applies to A/Gb mode only, but not to Iu mode

2.2 Abbreviations

Abbreviations used for GERAN *Iu mode* RRC Stage 2 and Stage 3 specifications are listed in 3GPP TS 21.905.
NOTE: 3GPP TS 21.905 may need to be updated.

AS	Access Stratum
BCCH	Broadcast Control CHannel
BSS	Base Station Subsystem
CN	Core Network
DBPSCH	Dedicated Basic Physical Sub CHannel

ECSD	Enhanced Circuit Switched Data
EDGE	Enhanced Data rates for Global Evolution
E-FACCH	Enhanced FACCH
E-IACCH	Enhanced Inband Associated Control CHannel
EGPRS	Enhanced GPRS
EPC	Enhanced Power Control
EPCCH	Enhanced Power Control CHannel
E-TCH	Enhanced TCH
FACCH	Fast Associated Control CHannel
FPC	Fast Power Control
GERAN	GSM/EDGE Radio Access Network
GPRS	General Packet Radio Service
GRA	GERAN Registration Area
G-RNTI	GERAN Radio Network Temporary Identity
GSM	Global System for Mobile Communications
IETF	Internet Engineering Task Force
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
LCS	LoCation Services
MAC	Medium Access Control
MCS-i	EGPRS Modulation and Coding Scheme i
MM	Mobility Management
MS	Mobile Station
NAS	Non Access Stratum
NSAPI	Network layer SAPI
Nt	Notification
O-FACCH	Octal FACCH
O-TCH	Octal TCH
PBCCH	Packet BCCH
PDCH	Packet Data CHannel
PDCP	Packet Data Convergence Protocol
PDP	Packet Data Protocol
PDTCH	Packet Data TCH
PDU	Packet Data Unit
PLMN	Public Land Mobile Network
PTCCH	Packet Timing advance Control CHannel
P-TMSI	Packet TMSI
QoS	Quality of Service
RAB	Radio Access Bearer
RANAP	Radio Access Network Application Part
RB	Radio Bearer
RLC	Radio Link Control
RNSAP	Radio Network Subsystem Application Part
ROHC	Robust Header Compression
RRC	Radio Resource Control
RTP	Real Time Protocol
SACCH	Slow Associated Control CHannel
SACCH/TP	SACCH for enhanced power control
SAP	Service Access Point
SAPI	Service Access Point Identifier
SDCCH	Stand-alone Dedicated Control CHannel
SDU	Service Data Unit
SBPSCH	Shared Basic Physical Sub CHannel
TBF	Temporary Block Flow
TCH	Traffic Channel
TDMA	Time Division Multiple Access
TN	Timeslot Number
TCP	Transmission Control Protocol
TLLI	Temporary Logical Link Identifier
TMSI	Temporary Mobile Subscriber Identity
UDP	User Datagram Protocol
UMTS	Universal Mobile Telecommunication System

USF	Uplink State Flag
UTRAN	UMTS Terrestrial Radio Access Network

2.3 Symbols

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

A	Interface between a BSS and a 2G MSC
Gb	Interface between a BSS and a 2G SGSN
Iu-cs	Interface between a BSS and a 3G MSC
Iu-ps	Interface between a BSS and a 3G SGSN
Iur-g	Interface between two BSSs
NOTE:	whether the Iur-g interface is also used between a BSS and an RNC
Um	Interface between MS and BSS

3. PRINCIPLES AND FUNCTIONS OF RRC PROTOCOL

3.1 Radio interface protocol architecture

In the C-plane, Layer 3 is partitioned into sub-layers where the lowest sub-layer, denoted as Radio Resource Control (RRC), interfaces with layer 2 and terminates in the GERAN.
In the Figure 1, below, the connections between RRC and MAC as well as RRC and L1 providing local inter-layer control services are shown. An equivalent control interface exists between RRC and the RLC sub-layer, between RRC and the PDCP sub-layer. These interfaces allow the RRC to control the configuration of the lower layers. For this purpose separate Control SAPs are defined between RRC and each lower layer (PDCP, RLC, MAC, and L1). Figure 1 reflects the radio interface protocol architecture as defined specifically in Release 5 connecting to the Iu interface.

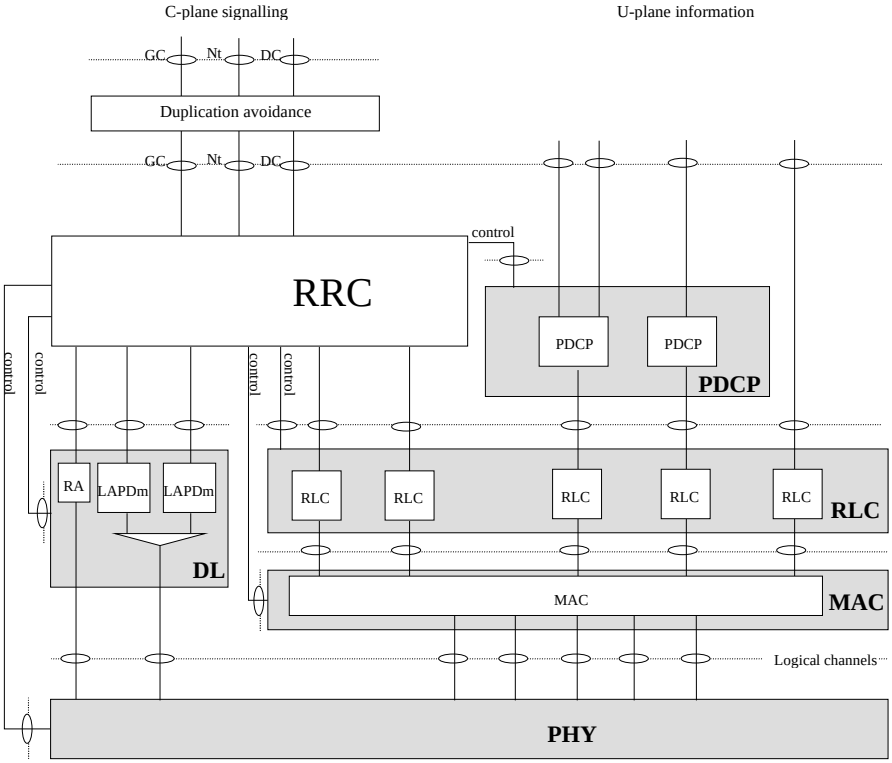


Figure 1: Radio Interface protocol architecture (see 3GPP TS 43.051)

3.2 High level functions of RRC

The Radio Resource Control (RRC) layer handles the control plane signalling of Layer 3 between the MS and GERAN. The RRC performs the following functions:

- **Broadcast of information provided by the non-access stratum (Core Network):** The RRC layer performs system information broadcasting from the network to all MSs. The system information is normally repeated on a regular basis. The RRC layer performs the scheduling, segmentation and repetition when such broadcasting is carried on BCCH. This function supports broadcast of higher layer (above RRC) information. This information may be cell specific or not. As an example RRC may broadcast Core Network location service area information related to some specific cells.

- **Broadcast of information related to the access stratum (GERAN):** The RRC layer performs system information broadcasting from the network to all MSs. The system information is normally repeated on a regular basis. The RRC layer performs the scheduling, segmentation and repetition when such broadcasting is carried on (P)BCCH. This function supports broadcast of typically cell-specific information.

- **Establishment, re-establishment, maintenance and release of an RRC connection between the MS and the GERAN:** The establishment of an RRC connection is initiated by a request from higher layers at the MS side to establish the first Signaling Connection for the MS. The establishment of an RRC connection includes an optional cell re-selection, an admission control, and layer 2 signaling link establishment. The release of an RRC connection can be initiated by a request from higher layers to release the last Signaling Connection for the MS or by the RRC layer itself in case of RRC connection failure. In case of connection loss, the MS requests re-establishment of the RRC connection. In case of RRC connection failure, RRC releases resources associated with the RRC connection.

- **Establishment, reconfiguration and release of Radio Bearers:** The RRC layer can, on request from higher layers, perform the establishment, reconfiguration and release of Radio Bearers in the user plane. A number of Radio Bearers can be established to an MS at the same time. At establishment and reconfiguration, the RRC layer performs admission control and selects parameters describing the Radio Bearer processing in layer 2 and layer 1, based on information from higher layers.

- **Assignment, reconfiguration and release of radio resources for the RRC connection:** Depending on the RRC and MAC states, the RRC layer may handle the assignment of radio resources needed for the RRC connection including needs from both the control and user planes. The RRC layer may reconfigure radio resources during an established RRC connection. RRC indicates to the MS resource allocations for purposes of inter system handovers.

- **RRC connection mobility functions:** The RRC layer performs evaluation, decision and execution related to RRC connection mobility during an established RRC connection, such as handover, preparation of handover to UTRAN or other systems, cell re-selection and cell/GRA update procedures, based on e.g. measurements done by the MS.

- **Release of signaling connections:** The RRC layer provides the necessary functions for the GERAN or the MS to request the release of a signaling connection.

- **Paging/notification:** The RRC layer can broadcast paging information from the network to selected MSs on PCCCH making use of the MAC layer services. Higher layers on the network side can request paging and notification. The RRC layer can also initiate paging during an established RRC connection.

- **Listening to BCCH**: The RRC layer may need to listen to the BCCH of the serving cell for working out whether *Iu mode* is supported in this cell. The RR layer is broadcasting system information on BCCH. The RRC layer listens to the BCCH of neighbouring cells for neighbour cell measurements; the RRC layer also receives paging information on the PCCCH. This function is an RR function, the RRC is not responsible for broadcasting on the BCCH

- **Routing of higher layer PDUs**: This function performs at the MS side routing of higher layer PDUs to the correct higher layer entity, at the GERAN side to the correct RANAP entity.

- **Control of requested QoS:** This function shall ensure that the QoS requested for the Radio Bearers can be met. This includes the allocation of a sufficient number of radio resources.

- **MS measurement reporting and control of the reporting:** the RRC layer including both GSM/EDGE air interface and other systems controls the measurements performed by the MS. The RRC layer is responsible for sending information that control the MS measurement reporting when

using the SACCH channel. The RRC layer also performs the reporting of the measurements from the MS to the network using SACCH.

- **Power control:** The RRC layer controls parameters for normal power control, enhanced power control and fast power control.
- **Control of ciphering:** The RRC layer provides procedures for setting of ciphering (on/off) between the MS and GERAN.
- **Integrity protection:** This function controls integrity protection and performs integrity protection those RRC messages that are considered sensitive and/or contain sensitive information.
- **Support for Location Services:** Signaling between MS and GERAN to support positioning of an MS.
- **Timing advance control:** The RRC controls the operation of timing advance on dedicated basic physical sub-channels.

3.3 RRC connections levels

3.3.1 Services provided to upper layers

The RRC offers the following services to upper layers (NAS),

- General Control;
- Notification control;
- Dedicated control.

RRC layer provides the MS GERAN portion of signalling connections to the upper layers to support the exchange of upper layer's information flow
The signalling connection is used between the mobile station and the core network to transfer upper layer information
For each core network domain, at most one signalling connection may exist at the same time
The RRC layer maps the signalling connections for one MS on a single RRC connection
For the upper layer data transfer on signalling connections, the RRC layer supports the discrimination between two different classes, named "High priority" (corresponding to "SAPI 0" when using RR) realised using Signalling Radio Bearer 3 and "Low priority" (corresponding to "SAPI 3" when using RR) realised using Signalling Radio Bearer 4.

3.3.2 Services provided to lower layers

RRC uses RLC/MAC as layer 2 in the control plane, except for operation on the BCCH, where the data link layer is used

3.4 Support of Radio Bearers in GERAN

The RRC layer is responsible for setting up radio bearers in the U-plane and the C-plane.
The Radio Bearer Concept in GERAN *Iu mode* is the same as in UTRAN. In Figure 2 the concept of radio bearer is illustrated.

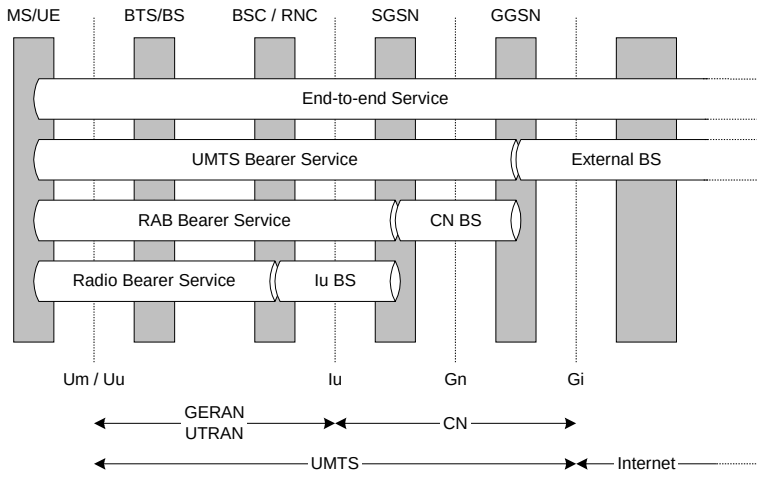


Figure 2: Support of Radio Bearers in GERAN and UTRAN (see 3GPP TS 25.922)

Bearer service provides the capability of transmission of signals between access points and is characterized by set of end-to-end characteristics with requirements on QoS. RAN creates and maintains RAB for communication between MS and CN.
RAN and the CN map the end-to-end QoS requirements over the Iu interface (Iu Bearer Services). RAN maintains the QoS over the radio path (Radio Bearer Service). A bearer is a service providing QoS between two defined points.
User Plane Radio Bearers are set-up when a Radio Access Bearer is required to be set-up by the Core Network.
Control Plane Radio Bearers are established when an RRC connection is set-up by an MS. Those comprise a set of four Signalling Radio Bearers:

- SRB 1 shall be used for all messages sent using RLC unacknowledged mode (RLC-UM).
- SRB 2 shall be used for all messages sent using RLC acknowledged mode (RLC-AM), except for the RRC messages carrying higher layer (NAS) signalling.
- SRB 3 and optionally SRB 4 shall be used for all RRC messages carrying higher layer (NAS) signalling and sent using RLC acknowledged mode (RLC-AM).

Association of SRBs 1 to 4 and logical channels is provided by the MAC protocol i.e. RRC does not see logical channels.
The mapping is defined in 3GPP TS 44.160, section 5.6.

3.5 RRC Connection Levels

The different levels of RRC connection between MS and GERAN are listed below:

- No signalling connection exists
  The MS has no relation to GERAN, only to CN. For data transfer, a signalling connection has to be established.
- A signalling connection exists
  There is an RRC connection between the MS and GERAN. The MS position can be known on different levels:
  - GERAN Registration Area (GRA) level
    The MS's position is known on GERAN registration area level. GRA is a specified set of cells, which can be identified in the PBCCH.
  - Cell level
    The MS's position is known on cell level.

3.5.1 Identities used in RAN

3.5.1.1 MS Identifiers

Radio Network Temporary Identities (RNTI) are used as MS/UE identifiers within GERAN/UTRAN and in signalling messages between MS/UE and GERAN.
Four types of RNTI exist:

- Serving BSS/RNC RNTI (S-RNTI);
- Drift BSS/RNC RNTI (D-RNTI);
- Cell RNTI (C-RNTI) (UTRAN only);
- UTRAN RNTI (U-RNTI) or GERAN RNTI (G-RNTI);

S-RNTI is used:

- by MS/UE to identify itself to the Serving BSS/RNC;
- by SBSS/SRNC to address the MS/UE;
- by DBSS/DRNC to identify the MS/UE to Serving BSS/RNC.

S-RNTI is allocated for all MSs/UEs having a RRC connection, it is allocated by the Serving BSS/RNC and it is unique within the Serving BSS/RNC. S-RNTI is reallocated always when the Serving BSS/RNC for the RRC connection is changed.
D-RNTI is used:

- by serving BSS/RNC to identify the MS/UE to Drift BSS/RNC.

Note: The D-RNTI is never used on Um/Uu.

D-RNTI is allocated by drift BSS/RNC upon drift MS/UE contexts establishment and it shall be unique within the drift BSS/RNC. Serving BSS/RNC shall know the mapping between S-RNTI and the D-RNTIs allocated in Drift BSSs for the same MS/UE. Drift BSS/RNC shall know the S-RNTI and SBSS-ID / RNC-ID related to existing D-RNTI within the drift BSS/RNC.
C-RNTI is used:

- only in UTRAN (and in case of Iur-g between UTRAN and GERAN specifically the case of a SBSS and DRNC);
- by UE to identify itself to the controlling RNC;
- by controlling RNC to address the UE.

C-RNTI is allocated by controlling RNC upon UE accessing a new cell. C-RNTI shall be unique within the accessed cell. Controlling RNC shall know the D-RNTI associated to the C-RNTI within the same logical RNC (if any).
G-RNTI/U-RNTI

The G-RNTI/U-RNTI is allocated to an MS/UE having a RRC connection and identifies the MS/UE within GERAN/UTRAN.
G-RNTI/U-RNTI is composed of:

- SBSS/SRNC identity;
- S-RNTI.

Each BSS/RNC has a unique identifier within the GERAN/UTRAN part of the PLMN, denoted by BSS/RNC identifier (BSS-ID/RNC-ID). This identifier is used to route GERAN/UTRAN interface messages to correct BSS/RNC. BSS-ID/RNC-ID of the serving BSS/RNC together with the S-RNTI is a unique identifier of the MS/UE in the GERAN/UTRAN part of the PLMN.
Reference
The identities are defined in 3GPP TS 43.130, 3GPP TS.43.051, 3GPP TS 25.413, 3GPP TS 25.331 and 3GPP TS 44.118.

3.5.1.2 RAN internal area identities

GERAN R5 will for *Iu mode* operation adopt the same split of MM and RRC functions between the CN and the RAN as UMTS. It is also proposed that GERAN R5 will adopt similar internal area identities that are used in UTRAN.
GMM states and the connection between RR modes and GMM fare described in 3GPP TS 23.060, section 6.1.1 and for Iu mode in section 6.1.2.

In the *A/Gb mode* the MM states for a GPRS subscriber are IDLE, STANDBY and READY. In the *Iu mode* the MM states for a GPRS subscriber are PMM-DETACHED, PMM-IDLE, and PMM-CONNECTED.
In MM IDLE state and PMM-DETACHED the mobile station is not registered to the (packet switched) network. Therefore, the network has no information about the mobile station and thus cannot follow the MS location. Decisions, regarding cell selection are made independently by the mobile station.
In the READY state the SGSN follows MS's location in cell level. After ready timer expiry the MS moves to STANDBY state where the location of the mobile station is followed only on routing area level. In the PMM-CONNECTED state the MS has a PS signaling connection, which consists of the RRC connection between the MS and the BSS and the Iu connection between the BSS and the 3G SGSN. In this state the BSC follows the MS location on cell or GERAN Registration Area (GRA) level while the SGSN knows the BSC, which is serving the MS.
When the mobile station moves from READY state to STANDBY state there is no information transfer ongoing or expected immediately between the mobile station and the network. For this reason, it is beneficial to stop reporting measurements and allow the mobile station to change cell more easily (lower cell re-selection hysteresis). When the mobile station moves from RRC-Cell_Shared state to RRC-GRA_PCH state or releases the RRC connection the situation is similar and therefore the behavior of the mobile station should be the same.
In below a mapping table between the *A/Gb mode* and *Iu mode* states is presented. This mapping is proposed be used regarding cases where RLC/MAC and RR/RRC procedures are connected to MM states. This way specifications where STANDBY and READY states have been referred are made applicable for the *Iu mode*.

Table 1 Mapping between the MM states in *A/Gb mode* and PMM/RRC states in the *Iu mode*

A/Gb mode MM state	Iu mode PMM/RRC state
IDLE	PMM-DETACHED
STANDY	RRC-Idle mode and RRC-GRA_PCH state
READY	RRC-Cell_Shared state

The RRC-Cell_Dedicated state has not been listed in the table. In this state, the MS mobility is handled controlled through handover procedure. Consequently, cell re-selection and MAC measurement reporting are not applicable.

Reference

The documents explaining the mapping between *A/Gb mode* and *Iu mode* states are: GP-022255, GP-022253, GP-022270 and GP-022254.

3.5.1.2.1 Registration Areas

One of the new RAN internal areas that will be introduced in GERAN R5 is the GERAN Registration Area (GRA). The GERAN Registration Area Identity (GRA Id) identifies a GERAN Registration Area (GRA) and is defined in 3GPP TS 44.118 and 3GPP TS 23.060. GRA Id can be used to indicate to the MS which GRA it shall use in case of overlapping of URA/GRAs. The definition of URA is in 3GPP TS 25.331. The GRA are similar to the UTRAN Registration Areas (URA) and will be used for an MS that operate in *Iu mode* and is in RRC-GRA_PCH state or RRC-Cell_Shared state. The GRA will be made up of one or more cells and multiple GRAs may overlap each other. GRAs can be allocated freely within the RAN and are allowed to overlap both the RAN internal areas such as the RNC area and also any NAS areas such as the LA/RA (Figure 3). This means that a GERAN Iu capable cell need support the possibility to broadcast multiple GRA identities in the cell (see 3GPP TS 44.160). The GRA Id is defined in 3GPP TS 44.118.

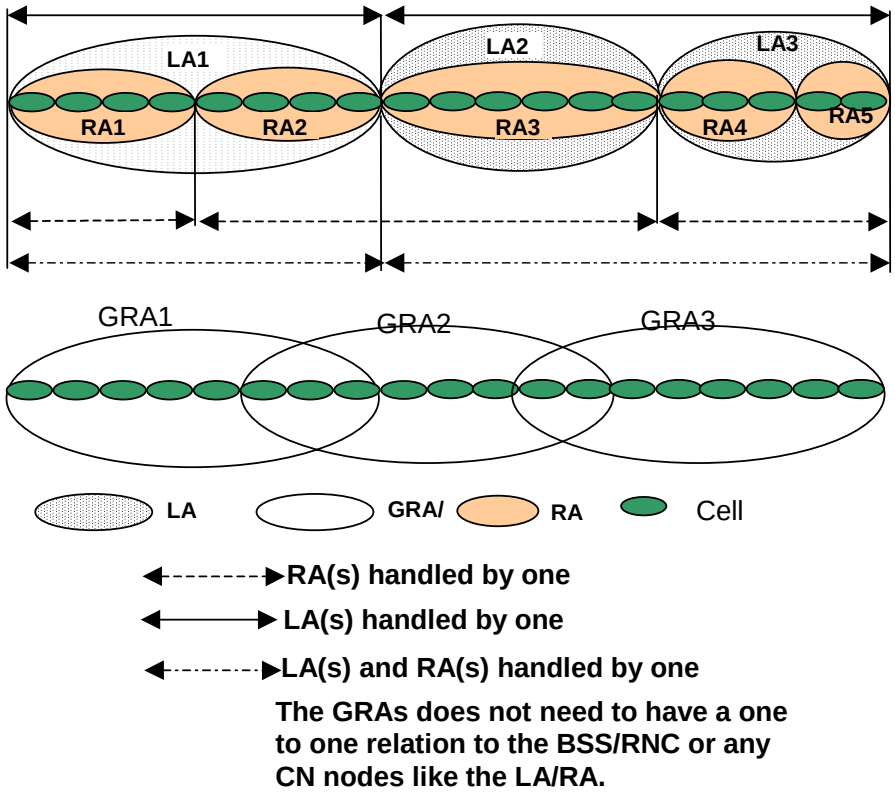


Figure 3: Area concept used in a GERAN Iu mode

Reference:

In UTRAN the area concept is defined in 3GPP TS 23.121 [13]. In GERAN *Iu mode* the definition of are concept is in 3GPP TS 43.051 and 3GPP TS 44.118, section 9.2.

3.6 RRC modes and states

3.6.1 General

The general description of the RRC modes and states is given in stage 3 document 3GPP TS 44.118. The RRC modes are RRC-Idle mode and RRC-Connected mode. RRC-Connected mode consists of three different RRC states: RRC-Cell_Shared, RRC-Cell_Dedicated and RRC-GRA_PCH state. RRC modes and states are shown in Figure 4.

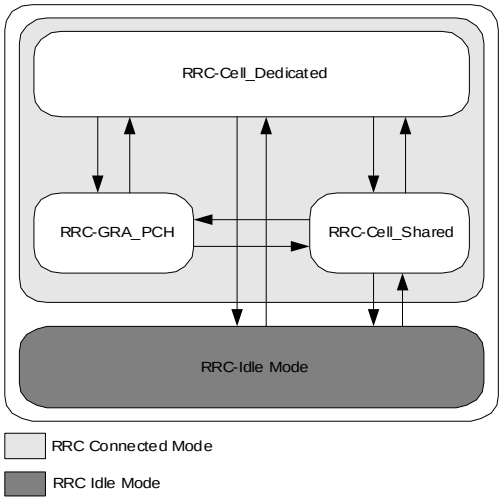


Figure 4: RRC states and modes for GERAN Iu mode

A general figure including the description of the transitions between the RRC states based on the procedures is presented below.

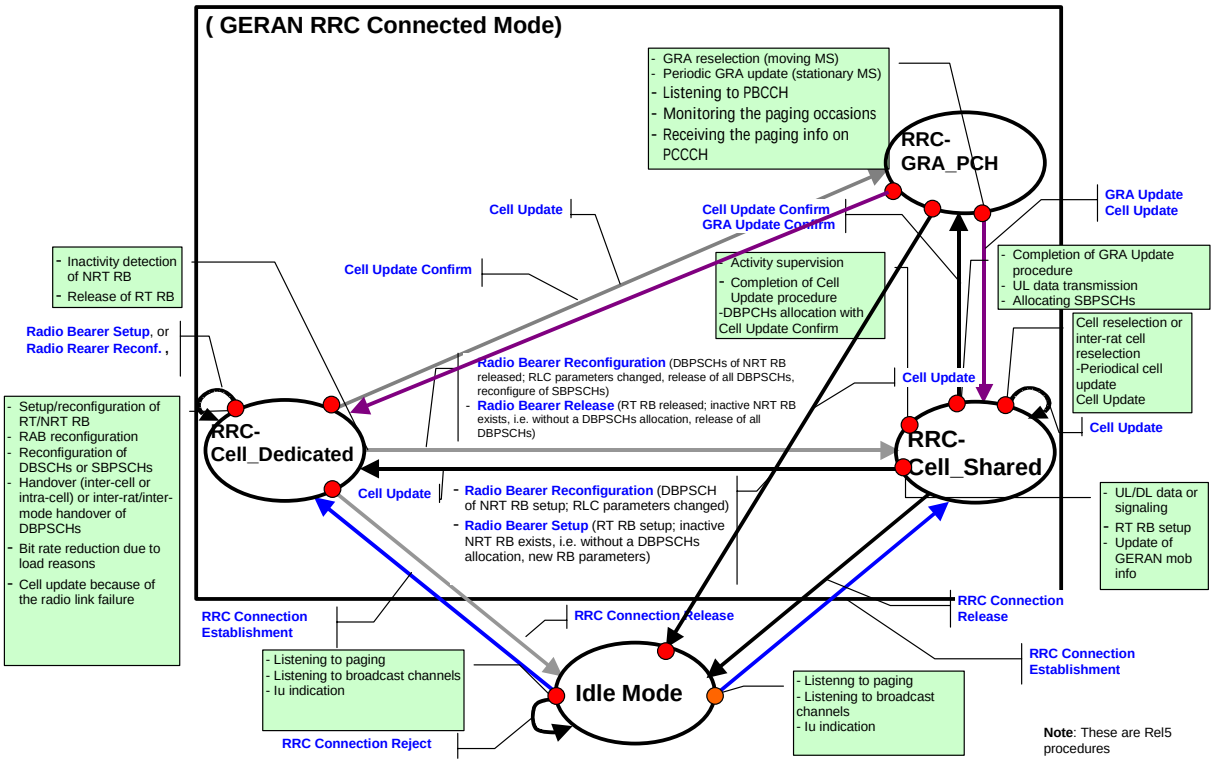


Figure 5: GERAN RRC states and modes

GERAN is required to broadcast SI messages on BCCH as specified in 3GPP TS 44.018
After power on the MS listens to BCCH and acquires the system information. The support of *Iu mode* shall be indicated in SYSTEM INFORMATION TYPE 3 message sent on BCCH. In addition, the support of *Iu mode* shall be indicated in either SYSTEM INFORMATION TYPE 4 or SYSTEM INFORMATION TYPE 7 and 8 messages.(see 3GPP TS 44.118, section 7.4). In the moment when the *Iu mode* support is indicated the MS enters to RRC-Idle mode and starts listening to the PBCCH. PBCCH is mandatory for both network and MS in *Iu mode*.

3.6.2 RRC-Idle mode

After power on the MS enters in RRC-Idle mode. This mode is characterized by:

- MS stays in RRC-Idle mode until a successful establishment of a RRC Connection.
- The connection of the MS is closed on all layers of the access stratum.
- MS listens to PBCCH (this is a function of the RLC/MAC –see 3GPP TS 44.160)
- MS is identified by NAS identities such as IMSI, TMSI or P-TMSI.
- GERAN has no own information about the individual MS's in RRC-Idle mode, and it can only address e.g. all MS's in a cell (broadcasting) or all MS's monitoring a paging occasion.

The transition to the RRC-Connected mode from the RRC-Idle mode can only be initiated by the MS by transmitting a request for an RRC Connection. The event is triggered by a request from upper layers in the MS.

At RRC connection establishment the MS is assigned a GERAN radio network temporary identity (G-RNTI) to be used as MS identity on both common control channels and traffic channels.
When the MS receives a message from the network that confirms the RRC connection establishment, the MS enters the RRC-Connected mode. The RRC-Connected mode is characterised by three states: RRC-Cell_Shared, RRC-Cell_Dedicated and RRC-GRA_PCH state.

3.6.3 RRC-Connected mode

3.6.3.1 RRC-Connected mode: RRC-Cell_Shared state

This state is characterized by:

- No dedicated basic physical sub-channel (DBPSCH) is allocated to the MS.
- The position of the MS is known by GERAN on cell level according to the cell where the MS last made a cell update
- MS actions while in RRC-Cell_Shared state:
- Initiate a Cell Update procedure on cell change to Iu mode in another GERAN or UTRAN cell
- Transmit signalling messages and user data in the uplink and/or the downlink using PDTCH when the MS is assigned use of those resources
- The management of radio resources within the cell is handled at MAC level or RRC level
- Listen to the PBCCH control channel of the serving cell for the decoding of system information messages
- Listen to neighbouring cells for neighbour cell measurements (see 3GPP TS 45.008);
- Use G-RNTI assigned in the current cell as the MS identity on common control channels

Radio resource allocation tasks:

- RRC is in this state responsible for allocating dedicated basic physical sub-channels, which causes the MS to enter the RRC-Cell_Dedicated state.
- MAC is responsible for allocating resources for already established RBs
- RRC is responsible for allocating / reallocating / releasing shared basic physical sub-channels (SBPSCH).
- Allocation of the PDTCHs by MAC is done according to the QoS class of the radio bearer and multislot capability of the MS.
- The RRC provides the MAC with QoS class and indication of the MS multislot capability.

RRC connection mobility tasks:

- MS shall initiate a Cell Update procedure when a new GERAN/UTRAN cell has been selected or the timer for cell update is expired.

MS measurements:

- MAC is responsible for measurement reporting, using the procedures defined in 3GPP TS 44.060.

3.6.3.2 RRC-Connected mode: RRC-Cell_Dedicated state

- MS is assigned one or more dedicated basic physical sub-channels (see 3GPP TS 43.051) in the uplink and downlink, which it can use anytime.
- MS may be assigned one or more shared basic physical sub-channels.
- The position of the MS is known by GERAN on cell level
- The MS shall perform the following actions:
    - Perform necessary procedures for measurement reporting;
    - Listen to neighbouring cells for neighbouring cell measurements (see 3GPP TS 45.008);
    - Perform a handover procedure of the dedicated basic physical sub-channels on cell change of another GERAN or UTRAN cell;
    - Transmit signalling message in the uplink using available signalling radio bearers.

Radio resource allocation tasks are described below:

- RRC is responsible for allocating new dedicated basic physical sub-channels,
- RRC are responsible for allocation of new shared basic physical sub-channels depending on the MAC control state.
- MAC is responsible for allocating resources for already existing RBs.
- RRC is also responsible for intra-cell handovers of dedicated basic physical sub-channels.

RRC connection mobility tasks are described below:

- RRC connection mobility tasks are realised in RRC-Cell_Dedicated state using RRC handover procedures.

MS measurements are described below:

- MS measurement results are signalled using RRC measurement procedures.

3.6.3.3 RRC-Connected mode: RRC-GRA_PCH state

This state is characterized below:

- No physical subchannel is allocated to the MS.
- The MS may use DRX for monitoring a PCCCH.
- No uplink activity is possible.
- The location of the MS is known on GERAN Registration area level
- MS shall initiate the following actions:
    - Monitor the paging occasions according to the DRX cycle and receive paging information on the PCCCH
    - Listen to the PBCCH control channel of the serving cell for the decoding of system information messages;
    - Initiate a GRA Update procedure upon GRA change.

Radio resource allocation tasks are described below:

- No radio resource allocation tasks are executed within this state.
- In case of transition to RRC-Cell_Shared state is needed, the MAC or RRC is responsible for allocating the shared physical sub-channels.
- In case of transition to RRC-Cell_Dedicated state is needed, the RRC is responsible for allocating the physical sub-dedicated channel.

RRC connection mobility tasks are described below:

- MS mobility is performed through Cell Reselection procedures.
- The MS shall perform cell reselection and upon selecting a new GERAN cell belonging to a GRA which does not match the GRA used by the MS, the MS shall move to RRC-Cell_Shared state and initiate a GRA update towards the network.
- After the GRA Update procedure has been performed, the MS shall change its state back to RRC-GRA PCH state if neither the MS nor the network has any more data to transmit.

MS measurements:

- MS monitors the broadcast channels on its own and neighbouring cells and identifies the need for GRA updating. No measurement reports are sent to the network in this state.***REFERENCE***

The RRC states and modes are described in 3GPP TS 44.118,section 6.4.

4. RRC FUNCTIONS

The RRC functions described below are excerpts from 3GPP TS 44.118, stage 3 description of RRC GERAN *Iu mode*. The main functions which are described in this document are the system broadcast and the detection of the *Iu mode*, paging, measurements, establsihement, re-establsihement, mainatainace of RRC connection, establishment, reconfiguration and release of the radio bearers, inter-rat and inter-mode handover, security and integrity protection function, signaling connection release and NAS procedures.

4.1 System information broadcast and the detection of the *Iu mode*

PBCCH is mandatory in GERAN *Iu mode* for both MS and network. MS listens to BCCH. The support of *Iu mode* shall be indicated in SYSTEM INFORMATION TYPE 3 message sent on BCCH. In addition, the support of *Iu mode* shall be indicated in either SYSTEM INFORMATION TYPE 4 or SYSTEM INFORMATION TYPE 7 and 8 messages. The SI3, SI4, SI7 and SI8 messages contain the CBQ3 parameter that indicates if *Iu mode* is supported in the cell (see 3GPP TS 44.018).
If *Iu mode* is supported and Gb mode is not supported in the cell, SYSTEM INFORMATION TYPE 13alt message shall be sent and the mobile station shall read SI13alt message. SI 13 message is not sent in this case. SI13alt message shall not be sent if *Iu mode* is not supported.
If Gb mode is supported, SYSTEM INFORMATION TYPE 13 message shall be sent and the mobile station shall read SI 13 message in this case. SI13alt message is not sent in this case. Additional requirements for the broadcast of system information in a cell supporting *Iu mode* and *Gb mode* are specified in 3GPP TSs 44.060 and 44.160.
Figure 6 presents the behaviour of *Iu mode* only capable mobile station and Figure 7 presents the behaviour of *A/Gb mode* and *Iu mode* capable mobile station on BCCH (see 3GPP TS 44.018).

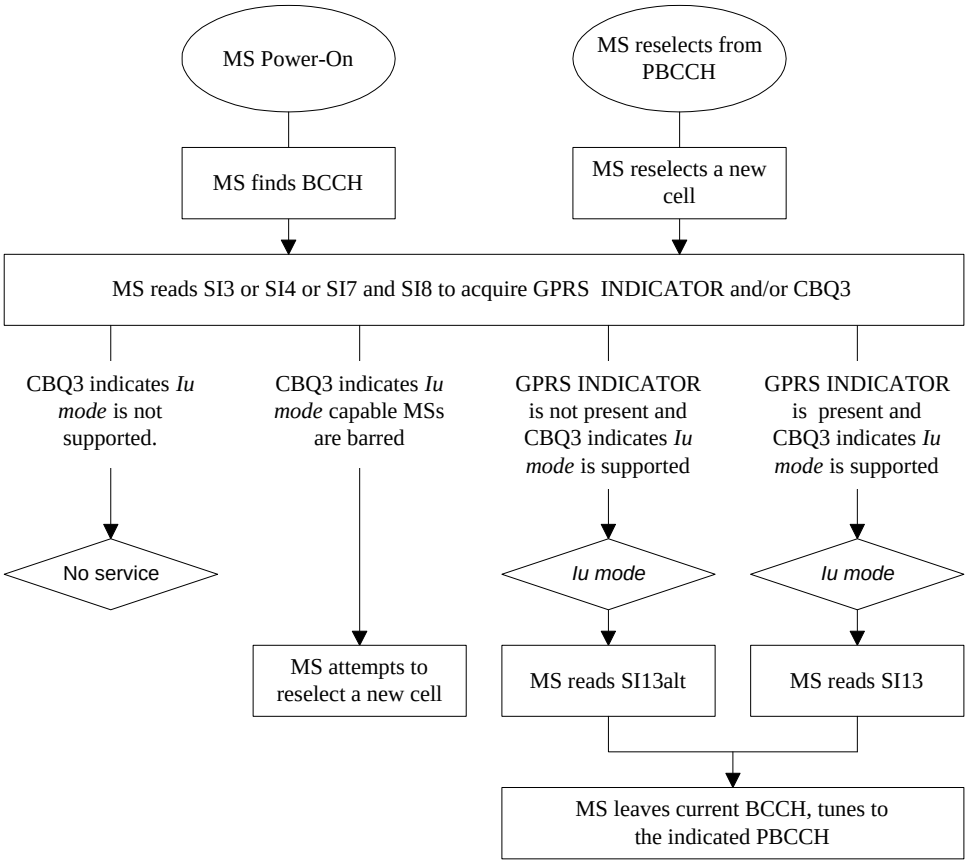


Figure 6: Behavior of Iu mode only capable MS on BCCH

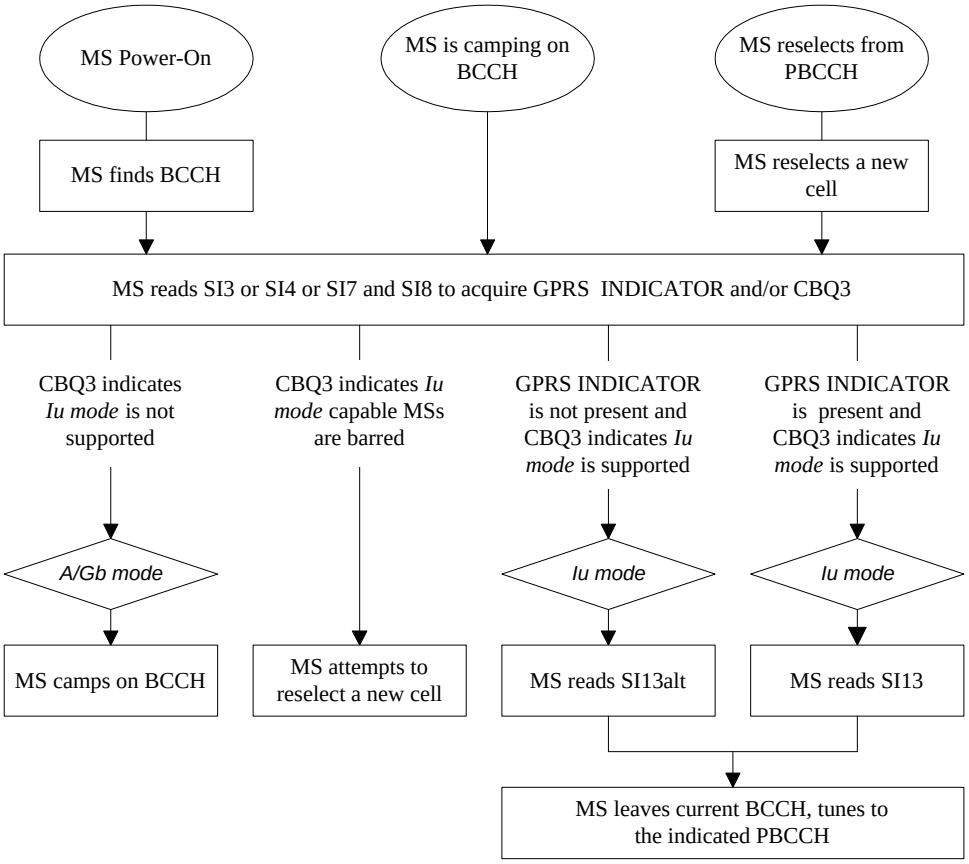


Figure 7: Behavior of A/Gb and Iu modes capable MS on BCCH

Reference:
The procedure is described in 3GPP TS 44.118,section 7.3, 3GPP TS 44.018 sub-clause 3.2.2.1 and 3GPP TS 44.060 sub-clause 5.5.1.2.

4.2 Paging

4.2.1 Paging initiation in RRC-Idle mode, RRC-Cell_Shared or RRC-GRA_PCH state

The paging initiation in RRC-Idle mode, RRC-Cell_Shared state or RRC-GRA_PCH state is done by sending a PAGING REQUEST service primitive to the GERAN MAC layer.

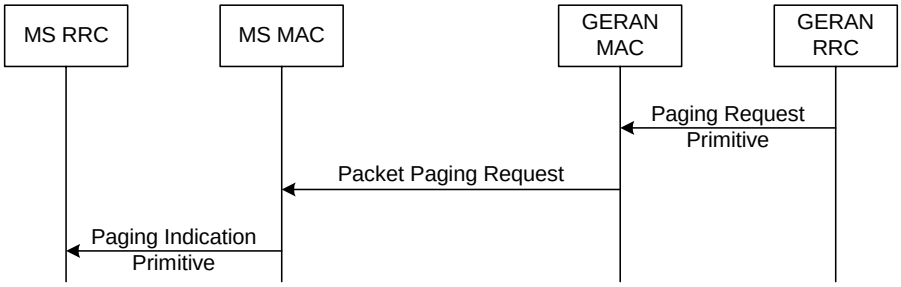


Figure 8: Paging Request procedure

This procedure is used to initiate transmission of paging information by the GERAN MAC to an MS in RRC-Idle mode, RRC-Cell_Shared state, or RRC-GRA_PCH state. Upper layers in the network may request paging, to e.g. establish a signalling connection between a mobile station and the CN. The GERAN may initiate paging of an MS in

RRC-GRA_PCH state or {RRC-Cell_Shared, MAC-Idle state} to trigger a Cell Update procedure (see 3GPP TS 44.118,section 7.8) in order to establish a signalling connection between the network and this MS.
An MS may use Discontinuous Reception (DRX) to reduce its power consumption. An MS in non-DRX mode monitors all paging blocks on the monitored PCCCH. An MS in DRX mode needs only to monitor the blocks corresponding to its paging group in order to reduce its battery consumption, see 3GPP TS 44.160.

Reference:
The procedure is described in 3GPP TS 44.118,section 7.4.1. The primitives between RRC and RLC/MAC are defined in 3GPP TS 44.160,section 4.3.

4.2.2 Paging initiation in RRC-Cell_Dedicated state

Figure 9: Dedicated Paging Request procedure

This procedure is used to transmit dedicated paging information to one MS in RRC-Cell_Dedicated state. Upon receipt of a DEDICATED PAGING REQUEST message the MS shall forward the *Paging Cause* IE, the *CN Domain Identity* IE and the *Paging Record Type Identifier* IE to upper layers.

Reference:
The procedure is described in 3GPP TS 44.118,section 7.4.2.

4.3 Establishment, re-establishment, maintenance and release of the RRC connection

This procedure is initiated by the MS in RRC-Idle mode to establish a signaling connection when requested by the upper layers.

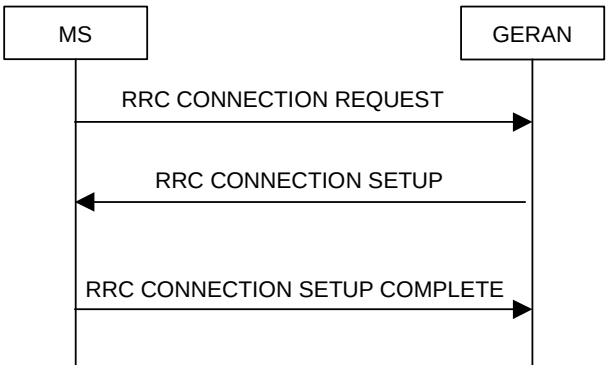


Figure 10. RRC Connection Establishment procedure, network accepts the connection

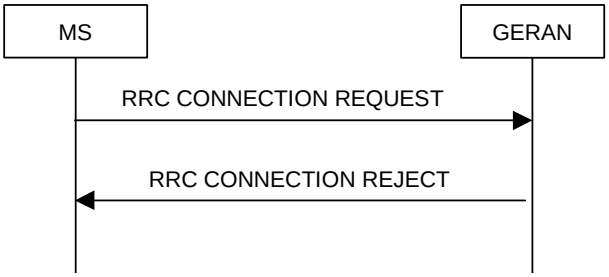


Figure 11. RRC Connection Establishment procedure, network accepts the connection

The procedure is initiated in the RRC-Idle mode and it is used to establish the first signalling connection for the MS. The procedure may include cell reselection or admission control. If connection is lost MS requests the re-establishment of the RRC connection.

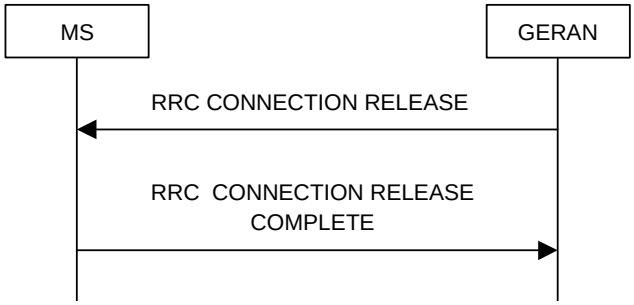


Figure 12: RRC Connection Release procedure

Release of the RRC connection is initiated by the request from the upper layers. In case of RRC connection failure RRC releases resources associated with the RRC connection. The network intiates the RRC connection release. The MS may be in RRC-Cell_Dedicated state or RRC-Cell_Shared state.

Reference
The RRC connection management procedures are described in 3GPP TS 44.118, section 7.5.1 and 7.5.2.

4.4 Radio Bearer Control procedures

Radio bearer control procedures include the establishment of new radio bearer (Radio Bearer Establishment procedures), reconfiguration of the existing radio bearer (Radio Bearer Reconfiguration procedures) and release of the radio bearer (Radio Bearer Release procedures).

These procedures are used to change the RB parameters (e.g due to QoS change) or to setup, reconfigure or release physical channel parameters. Shared and dedicated basic physical sub-channels can be setup/reconfigured/release by the radio bearer control procedures. Handover of the dedicated channels is done using Radio bearer reconfiguration procedures. MS can initialize the request of the shared resources while in RRC-Cell_Dedicated state using DTM procedures. In this case MAC state is changing from MAC-Dedicated to MAC-DTM state.

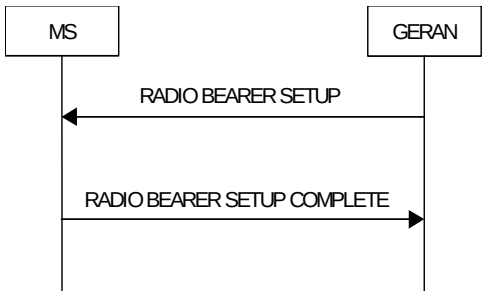


Figure 13. Radio Bearer Establishment, normal case

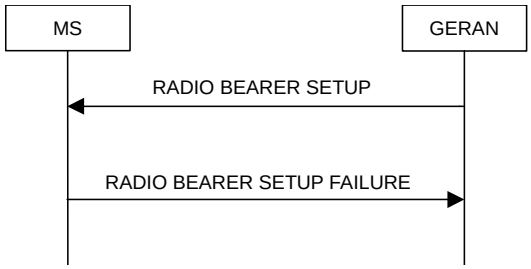


Figure 14. Radio Bearer Establishment, MS reverts to the old configuration

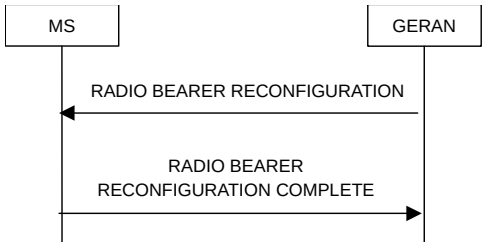


Figure 15. Radio Bearer Reconfiguration, normal flow

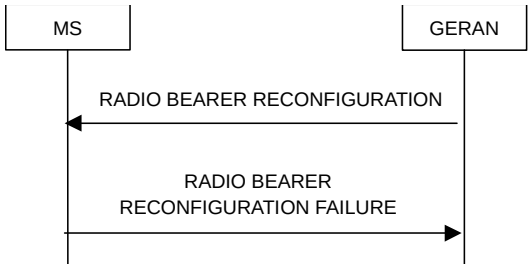


Figure 16. Radio Bearer Reconfiguration, MS reverts to the old configuration

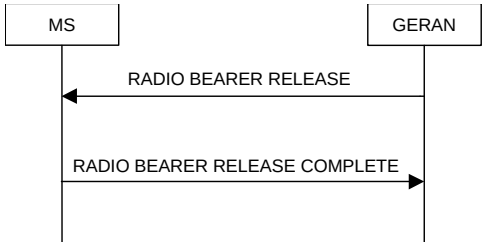


Figure 17. Radio Bearer Reconfiguration, normal flow

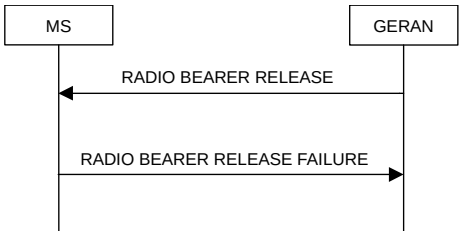


Figure 18. Radio Bearer Reconfiguration, MS reverts to the old configuration

The procedures are ending at the MS side when the MS goes to the new configuration and sends the complete message (Radio Bearer Setup Complete, Radio Bearer Reconfiguration Complete or Radio Bearer Release Complete).
In case that failure case occurs due to indication of the unimplemented frequency or unsupported configuration or protocol error, then failure message is sent to the network in response and MS reverts to the old configuration.

4.4.1 MS initiated DTM procedures while in RRC-Cell_Dedicated-MAC-Dedicated state

While in RRC-Cell_Dedicated-MAC-Dedicated state, the establishment of one or more SBPSCHs may be initiated by the RRC entity of the mobile station using the DTM Request procedure. The procedure is used only for existing radio bearers and is triggered by a request from upper layers to transfer an upper layer PDU. The mobile station initiates the DTM Request procedure by sending a GERAN Iu mode DTM REQUEST message on the SRB2.
The MS shall set the IEs in the GERAN Iu mode DTM REQUEST message as described in section 7.14.2, 3GPP TS 44.118.
If the network cannot allocate the requested SBPSCH(s) it may send to the mobile station a GERAN Iu mode DTM REJECT message.

Reference
The procedures are described in 3GPP TS 44.118, section 7.14.

4.5 Handover and cell reselection procedures

4.5.1 Handover GERAN *Iu mode* -GERAN *Iu mode*

Handover GERAN Iu mode to GERAN Iu mode is based on the same principles like UTRAN to UTRAN, as described in UTRAN stage 3 description 3GPP TS 25.331. The procedure used to handover dedicated channels is Radio Bearer Reconfiguration procedure. The change of the physical channels is the same as in GSM handover procedures, see 3GPP TS 44.018, 3.4.4. Physical channel establishment is described in 3GPP TS 44.118, 7.18.6. In Rel5 Handover Access message and Physical Information messages are layer 2 messages, see 3GPP TS 44.160, section 9.3a.
The Radio Bearer Reconfiguration message is sent by the network with the new DBPSCH parameters (TCH or PDTCH). Then the MS tries to access the new cell using the access burst as in GSM. When the access in the new cell succeeded and the MS goes to the new configuration, the Radio Bearer Reconfiguration Complete message is sent to the network. The relevant signalling flow is described in 3GPP TS 23.009 for CS domain and 3GPP TS 23.060 for PS domain.
The figure 19 shows the mechanism implemented for the handover access procedure in the new cell.

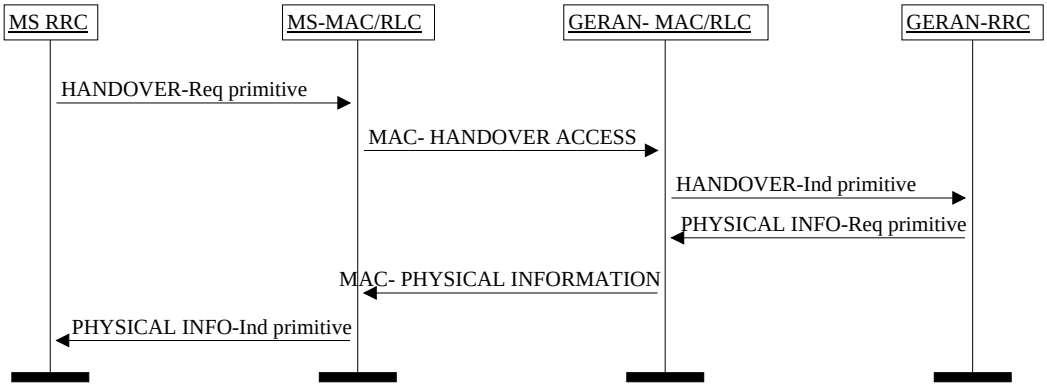


Figure 19: Handover Access procedure

The Handover Access procedure initiation in RRC-Cell_Dedicated state is done by sending a HANDOVER-Req primitive to the MS MAC layer as described in 3GPP TS 44.160. The MS MAC uses this procedure to initiate access in the new cell. The reception of a HANDOVER ACCESS message at GERAN MAC is indicated to GERAN RRC by sending the HANDOVER-Ind primitive as specified in 3GPP TS 44.160.
The Physical Information procedure initiation is done by sending a PHYSICAL INFO-Req primitive to the GERAN MAC layer as specified in 3GPP TS 44.160 upon receipt of a HANDOVER-Ind primitive from the GERAN MAC layer. When the network has the necessary mobile station's RF characteristics it sends PHYSICAL INFORMATION message as specified in sub-clause 7.18.6.2. The reception of a PHYSICAL INFORMATION message at MS MAC is indicated to the MS RRC by sending the PHYSICAL INFO-Ind primitive.
Four procedures are defined: Finely synchronized cell, Non-synchronized cell, Pseudo-synchronized cell and Pre-synchronized cell. The support of all of them except the pseudo-synchronized cell case is mandatory in the mobile

station. A pseudo-synchronized establishment can be commanded only to a mobile station that can support it, as indicated in the classmark.

The handover procedure ends at the MS side when MS establish/reconfigure the new channels and sends to the network Radio bearer Reconfiguration complete message. Rel5 specifies only the handover of the dedicated channels while in RRC-Connected mode, RRC-Cell_Dedicated state. In case of inter-BSC or intra-BSC handover the MS shall keep the RRC connection on.

Reference

These procedures are described in 3GPP TS 44.118 sections 7.14 and 7.18.6 and 3GPP TS 44.160 section 9.3a.

4.5.2 Handover and cell reselection between GERAN *Iu mode* –UTRAN

The general figure of the Handover between GERAN *Iu mode* and UTRAN (and vice-versa) is shown below. This is named as Inter-RAT handover and inter-rat cell reselection between GERAN *Iu mode* and UTRAN. These procedures are similar with UTRAN to UTRAN relocation procedures as described in stage 3,3GPP TS 25.331 and stage 2 GPRS 23.060 and 23.009.

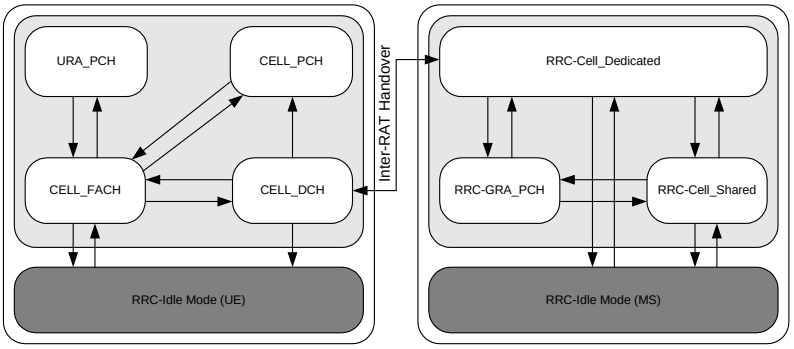


Figure 20. Handover between GERAN Iu mode and UTRAN

4.5.2.1 Inter-RAT handover between GERAN Iu mode and UTRAN

When a handover which results in change from GERAN *Iu mode* (i.e. RRC-Cell_Dedicated state) to UTRAN is performed, the UTRAN RRC connected mode of operation shall be entered.
When a handover which results in change from UTRAN (i.e. from the UTRA RRC Cell_DCH state) to GERAN *Iu mode* is performed, the RRC-Cell_Dedicated state shall be entered.
This procedure is only valid for UTRAN capable MSs. A change to UTRAN channel(s) can be requested by the network RRC sublayer in RRC-Cell_Dedicated state.
In case of the handover to UTRAN procedure the MS shall reconfigure layer 2, disconnect and deactivate of physical channels and their release (layer 1) and establish the UTRAN channel(s), see 3GPP TS 25.331. The network initiates the handover to UTRAN procedure by sending an INTER SYSTEM TO UTRAN HANDOVER COMMAND message to the mobile station on the SRB2 in GERAN in *Iu mode*. The INTER SYSTEM TO UTRAN HANDOVER COMMAND message shall contain encapsulated the ***HANDOVER TO UTRAN COMMAND*** (this should be decided). If the INTER SYSTEM TO UTRAN HANDOVER COMMAND refers to a not known cell (see 3GPP TS 25.133 and 3GPP TS 25.123), this shall not be considered as an error. The procedure is considered successful at the mobile side when the MS establishes the new channels in UTRAN.
The MS has the RRC connection on all the time in case of inter-rat handover.

Reference
The procedures are described in 3GPP TS 44.118, section 7.10.

4.5.3 Cell reselection between GERAN *Iu mode* and UTRAN

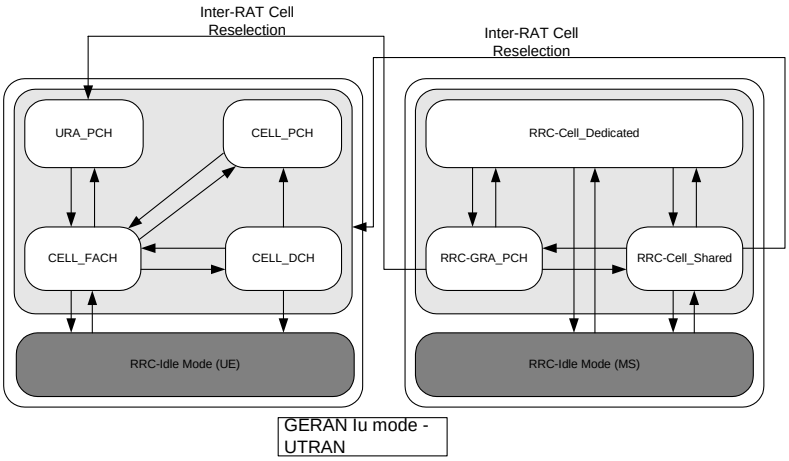


Figure 21. Cell reselection GERAN Iu mode – UTRAN

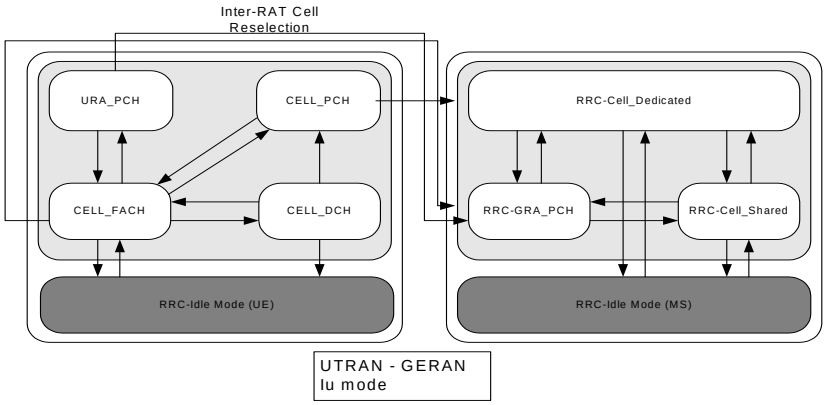


Figure 22. Cell Reselection UTRAN-GERAN *Iu mode*

Cell reselection in this section refers to aborting the operation in the old cell and switching to the new selected cell.
When a cell reselection which results in change from GERAN *Iu mode* to UTRAN is performed, when the MS is in RRC-Idle mode, the Idle mode of operation shall be entered.
When a cell reselection which results in change from GERAN *Iu mode* to UTRAN is performed, when the MS is in GERAN RRC-Cell_Shared state, the MS shall initiate the cell update procedure and enter the UTRAN RRC Cell Shared state. If the cell update is rejected by UTRAN, the MS shall release the RRC connection according to the cell update failure case and enter Idle mode.
When a cell reselection which results in change from GERAN *Iu mode* to UTRAN is performed, when the MS is in GERAN RRC-GRA_PCH state, the MS shall enter the UTRAN RRC URA_PCH state. If the GRA identity which the MS had been assigned to in GERAN is not present in the list of URA identities broadcast in the UTRAN cell, the MS shall initiate the UTRAN URA update procedure. If the URA update is rejected by UTRAN, the MS shall release the RRC connection according to the URA update failure case and enter Idle mode.
When a cell reselection which results in change from UTRAN to GERAN *Iu mode* is performed, when the MS is in UTRAN RRC-Cell_FACH or Cell_PCH state, the MS shall initiate the cell update procedure and enter the GERAN RRC Cell Shared state. If the cell update is rejected by GERAN, the MS shall release the RRC connection according to the cell update failure case and enter RRC Idle mode in GERAN *Iu mode*.
When a cell reselection which results in change from UTRAN to GERAN *Iu mode* is performed, when the MS is in UTRAN RRC-URA_PCH state, the MS shall enter the GERAN RRC GRA_PCH state. If the URA identity which the

MS had been assigned to in UTRAN is not present in the list of GRA identities broadcast in the GERAN cell, the MS shall initiate the GERAN GRA update procedure. If the GRA update is rejected by GERAN, the MS shall release the RRC connection according to the GRA update failure case and enter RRC Idle mode in GERAN *Iu mode*.

Reference
The procedures are described in 3GPP TS 44.118, section 7.8.1.17 and 3GPP TS 25.331 section 8.3.8.

4.5.4 Handover and cell reselection between GERAN *Iu mode*- GERAN *A/Gb mode*

The general figure of cell reselection between GERAN *Iu mode* and GERAN *A/Gb mode*. The handover between GERAN *Iu mode* and GERAN *A/Gb mode* is denoted as inter-mode handover.

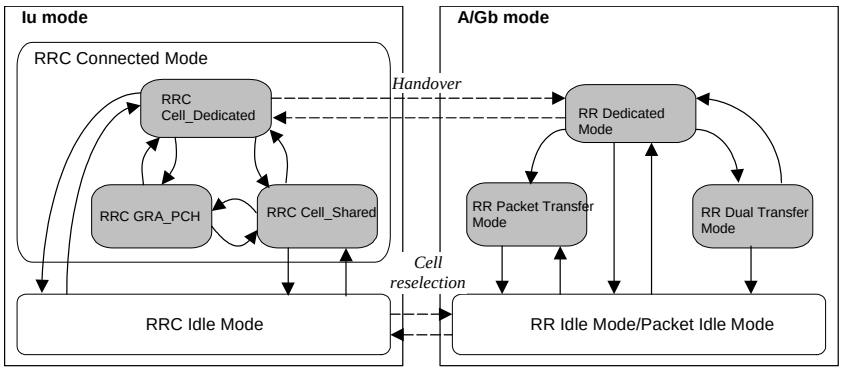


Figure 23. Transitions between RR modes of operation and RRC states and modes.

4.5.4.1 Handover between GERAN Iu mode and GERAN A/Gb mode

When a handover which results in change from *Iu mode* (i.e. from the RRC-Cell_Dedicated state) to *A/Gb mode* is performed, the RR dedicated mode of operation shall be entered.
When a handover which results in change from *A/Gb mode* (i.e. from the RR dedicated mode of operation) to *Iu mode* is performed, the RRC-Cell_Dedicated state shall be entered. If handover to *Iu mode* is triggered in RR dual transfer mode of operation, the RR dedicated mode of operation shall be entered before the handover is initiated.
The handover to GERAN A/Gb mode is shown in Figure 24 and Figure 25, successful and failure cases.

Figure 24. Inter-mode handover from GERAN, successful case

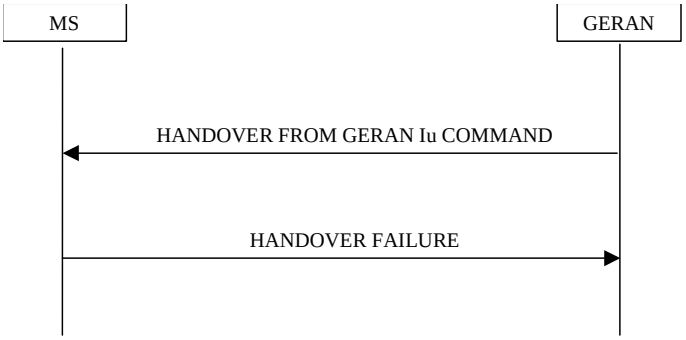


Figure 25. Inter-mode handover from GERAN *Iu mode*, failure case

The purpose of the Inter-Mode Handover from GERAN Iu procedure is to, under the control of the network, transfer a connection between the MS and GERAN *Iu mode* to GERAN *A/Gb mode*. This procedure may be used to request an intercell or intracell change of channel(s) by the network, in RRC-Cell_Dedicated state. This procedure is applicable to CS domain service.
The procedure is initiated when GERAN Iu mode orders a MS in RRC-Cell_Dedicated state, to make a handover to GERAN *A/Gb mode*.
To initiate the procedure, GERAN sends a HANDOVER FROM GERAN Iu COMMAND message.
Upon the receipt of HANDOVER FROM GERAN Iu COMMAND message, the mobile station shall initiate reconfiguration of the layer 2 and disconnection of the DBPSCHs, switch to the assigned cell(s) and establish the physical channels as described in 3GPP TS 44.018.
The MS shall be able to receive a HANDOVER FROM GERAN Iu COMMAND message and perform an inter-mode handover, even if no prior MS measurements have been performed on the target cell. The connection is established in GERAN *A/Gb mode* by using the contents of encapsulated message HANDOVER COMMAND message (see 3GPP TS 44.018). At the MS side the procedure ends when the MS establishes the channels in A/Gb mode and can send Handover complete message, see 3GPP TS 44.018.
In this case the RRC connection is not kept on. The RR connection is established in the new cell as it is specified in stage 3 description 3GPP TS 44.018.

Reference
This procedure is defined in 3GPP TS 44.118, section 7.8.4.

4.5.4.2 Cell reselection between GERAN *Iu mode* and GERAN *A/Gb mode*

Cell reselection in this section refers to aborting the operation in the old cell and switching to the new selected cell.
When a cell reselection which results in change from *Iu mode* (i.e from the RRC-Idle Mode) to *A/Gb mode* is performed, the RR Idle/ RR Packet Idle mode of operation shall be entered. If cell reselection is triggered in RRC-Cell_Shared or RRC-GRA_PCH state, the RRC-Idle mode shall be entered before the cell reselection is initiated.
When a cell reselection, which result in change from *A/Gb mode* (i.e. from the RR Idle/RR packet Idle mode of operation) to *Iu mode*, is performed the RRC-Idle mode shall be entered. If cell reselection is triggered in RR Packet Transfer mode of operation, the RR packet Idle mode of operation shall be entered before the cell reselection is initiated.

Reference
These procedures are described in 3GPP TS 44.060, 3GPP TS 44.118 and 3GPP TS 44.160.

4.6 Security procedures

In GERAN *Iu mode* security procedures are used in RRC Connected mode. The integrity protection is controlled by the RRC entity and is applied to all RRC messages except the ones mentioned in 3GPP TS 44.118, 7.18. The integrity protection is applied only to the RRC messages.
The general security mode procedures are described in the figure below. The security mode command procedures are initiated by the RRC level.

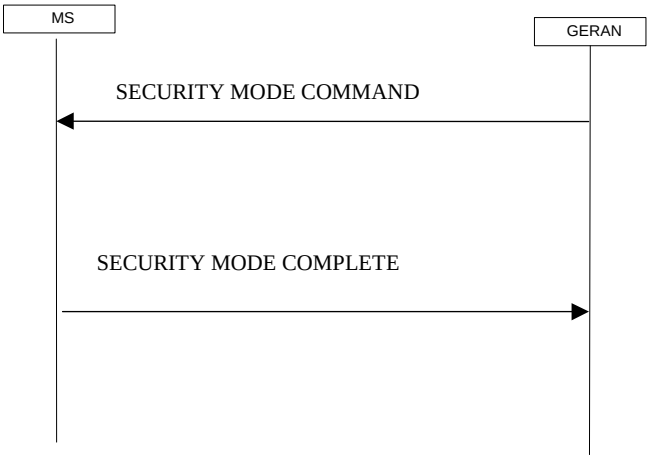


Figure 26: Security mode control procedure

4.6.1 Ciphering in GERAN Iu mode

The ciphering architecture is specified in 3GPP TS 33.102 and is identical to that of UTRAN (f8). The ciphering principle with input parameters to the algorithm is illustrated in stage 2 description of GERAN Iu mode, 3GPP TS 43.051. The ciphering function is performed either in the RLC sub-layer or in the MAC sub-layer, see stage 3 description in 3GPP TS 44.160.
The ciphering key is 128 bit long.

The ciphering key is established between the MS and BSS during the authentication phase. In the two-key solution, the CS-domain user-plane bearers are ciphered with the most recent cipher key agreed between the user and the MSC (CK-CS). The PS-domain user-plane bearers are ciphered with the most recent cipher key agreed between the user and the SGSN (CK-PS).

The signalling radio bearers are used for transfer of signalling data for services delivered by both CS and PS service domains. These signalling radio bearers are ciphered using the CK of the service domain for which the most recent security mode negotiation took place. This may require that the cipher key of an (already ciphered) ongoing signalling connection has to be changed, when a new connection is established with another service domain, or when a security mode negotiation follows a re-authentication during an ongoing connection.

To ensure performing the right ciphering function at the RLC and MAC layers, three conditions must be met:

- A user-plane Radio Bearer is either from CS-domain or PS-domain, but not from both.
- RRC maps a given user-plane Radio Bearer to a given domain in order to derive the correct key to utilise for each RB.
- The RLC and MAC layers receive the Radio Bearer IDs and CKs they should use from RRC

Two ciphering keys are provided to the lower layers, for each CN domain.

RRC is used to trigger the start of ciphering or to command the restart of the ciphering with a new ciphering configuration, for the radio bearers of one CN domain and for all signalling radio bearers.

When configuring ciphering, GERAN shall ensure that the MS needs to store at most two different ciphering configurations (keyset and algorithm) per CN domain, in total over all radio bearers at any given time. For signaling radio bearers the total number of ciphering configurations that need to be stored is at most three.

4.6.2 Integrity protection in GERAN Iu mode

RRC layer is also used to start integrity protection or to modify the integrity protection configuration for all signalling radio bearers.

Integrity protection with a 32-bit MAC-I shall be performed on all RRC messages, with the exceptions defined in 3GPP TS 44.118, section 7.18.5.

There may be one IK for CS connections (IK_{CS}), established between the CS service domain and the user and one IK for PS connections (IK_{PS}) established between the PS service domain and the user.
The data integrity of radio bearers for user data is not protected.
The signalling radio bearers are used for transfer of signalling data for services delivered by both CS and PS service domains. These signalling radio bearers are data integrity protected by the IK of the service domain for which the most recent security mode negotiation took place. This may require that the integrity key of an (already integrity protected) ongoing signalling connection has to be changed, when a new connection is established with another service domain, or when a security mode negotiation follow a re-authentication during an ongoing connection.

4.6.2.1 Calculation of message authentication code

The MS shall calculate the message authentication code in accordance with 3GPP TS 33.102 Security Architecture

The MS shall calculate the message authentication code in accordance with 3GPP TS 33.102.

4.6.2.2 Maintenance of Hyper Frame Numbers

The MSBs of both the ciphering sequence numbers (COUNT-C) and integrity sequence numbers (COUNT-I), for the ciphering and integrity protection algorithms, respectively (see3GPP TS 33.102), are called the Hyper Frame Numbers (HFN). For TM RLC bearers an extended TDMA frame number is used, which is built by an HFN plus part of a TDMA frame number.
For integrity protection, the MS shall:

- Maintain COUNT-I as specified in sub-clause 3GPP TS 44.118, 7.18.5;

The following hyper frame numbers types are defined:

MAC HFN:
11 MSB of COUNT-C for data sent over RLC TM

RLC HFN:

If the RLC sequence number is of length 7 bits(GPRS TBF mode, see 3GPP TS 44.160), then the HFN

- defines the 24 MSB of the COUNT-C parameter for data sent over RLC UM, and
- defines the 24 MSB of the COUNT-C parameter for data sent over RLC AM.

If the RLC sequence number is of length 11bits (EGPRS TBF mode, see 3GPP TS 44.160), then the HFN

- Defines the 20 MSB of the COUNT-C parameter for data sent over RLC UM, and
- Defines the 20 MSB of the COUNT-C parameter for data sent over RLC AM.

If the RLC sequence number is of length 4 bits (DCCH TBF mode, see 3GPP TS 44.160), then the HFN

- Defines the 27 MSB of the COUNT-C parameter for data sent over RLC UM, and
- Defines the 27 MSB of the COUNT-C parameter for data sent over RLC AM.

If the RLC sequence number is of length 8 bits (TCH TBF mode, see 3GPP TS 44.160), then the HFN

- Defines the 23 MSB of the COUNT-C parameter for data sent over RLC UM, and
- Defines the 23 MSB of the COUNT-C parameter for data sent over RLC AM.

RRC HFN:
28 MSB of COUNT-I.

For non-transparent mode RLC radio bearers, the MS shall:
Maintain one uplink and one downlink COUNT-C per radio bearer and one uplink and one downlink COUNT-I per signalling radio bearer.

For all transparent mode RLC signalling radio bearers and radio bearers of the same CN domain, the MS shall:

Maintain one COUNT-C, common for all signalling radio bearers and radio bearers in uplink and downlink;

If the activation time for a new ciphering configuration set by an RRC procedure is equal to zero:

- apply the configured MAC HFN at this activation time, i.e. the configured HFN is not incremented;
- maintain one uplink and one downlink COUNT-I per signalling radio bearer.

4.6.2.3 START value calculation

In RRC connected mode, the START value for CN domain 'X' is calculated as
Let $START_X$ = the START value for CN domain 'X' prior to the calculation below:
$START_X' = MSB_{20}$ (MAX {COUNT-C, COUNT-I | radio bearers and signalling radio bearers using CK_X and IK_X}) + 2.

- if $START_X'$= the maximum value = 20^2 –1 = 1048575 then $START_X = START_X'$;
- if the current $START_X < START_X'$ then $START_X = START_X'$, otherwise $START_X$ is unchanged.

4.6.2.4 Handling of HFN in case of the inter-rat handover and inter-rat cell reselection

In case of the inter-rat handover and cell reselection the values of the HFN is sent inside the SBSS or SRNS relocation inform (RRC transparent container) containers. These containers are defined in the 25.331 (if the target system is UTRAN) and in the 44.118 (if the target system is GERAN). Also the START values are transferred and they are stored in the variable to the target system to the same value which are used in the source system. The case of handover from GERAN Iu mode to UTRAN and vice versa the integrity keys and the ciphering keys are kept on. These procedures are seen as relocation procedures and they are similar defined as UTRAN-UTRAN. The same principle is applied for the inter-BSC handover. The RRC container parameters transferred over RANAP are defined in 3GPP TS 44.118,section 11.

4.6.2.4.1 Handling of HFN at the network side

The length of RLC counters in UTRAN (RLC-AM 20bits, RLC-UM 25bits) and GERAN-Iu are different. In GERAN-Iu there are additional differences between GPRS (RLC-AM and RLC-UM 24bits) and EGPRS (RLC-AM and RLC-UM 20bits).
The network nodes shall use the following HFN mapping rules when sending or receiving HFN values within the RRC information containers:

The source network node shall set the HFN value as used in the source cell,

If the target network node receives an HFN value with the same length as used in the target cell;

- Increment this HFN by 1; and
- Use this value as HFN in the target cell;

if the target network node receives an HFN which is longer than the one used in the target cell;

- Take the MSBs as needed for the target cell;
- Increment this value by 1; and
- Use this value as HFN in the target cell;

If the target network node receives an HFN which is shorter than the one used in the target cell;

- Increment this HFN by 1;
- Add a number of least significant zero bits as needed; and
- Use this value as HFN in the target cell.

4.6.2.4.2 Handling of the HFN at the MS side

Upon sending the response message and in case that the network indicates that SBSS/SRNS relocation took place, the MS shall calculate the HFN values as follows

- Set the 20 most significant bits of the uplink and downlink HFN component of COUNT-C of SRB2 to MAX(uplink HFN_U, downlink HFN_U) where HFN_U is the HFN component of COUNT-C of SRB2 in UTRAN;
- Set the remaining bits of the uplink and downlink HFN component of COUNT-C of SRB2 equal to zero;
- Increment by one the downlink and uplink values of the HFN component of COUNT-C for SRB2;
- Calculate the START value according to sub-clause 7.18 in 3GPP TS 44.118;
- Include the START values In the response messages
- Set the variables for ciphering and integrity protection as specified in sub-clause 7.14.1.3, 3GPP TS 44.118.
-

4.6.3 Successful security mode command procedure

The ciphering mode or integrity mode is changed in the MS if the Security mode command message has indicated this. Integrity key is changed when the service domain changed or when a security mode negotiation follow a re-authentication during an on going procedure. MS will send the Security mode command complete when the new ciphering mode or integrity mode is completed and the new START values and HFN are calculated.

Reference
The procedures are described in the stage 3 description of the RRC GERAN Iu mode, 3GPP TS 44.118, sections 7.16 and 7.18.

4.7 MS capability enquiry

'In GERAN *Iu mode* MS capability handling is moved from MAC layer to RRC layer. The MS sends its capabilities in the RRC connection establishment procedures. The capabilities are sent to GERAN not to CN and they are common for PS and CS domain.

4.7.1 MS Capability Handling in GERAN *Iu mode*

The major principles relating to MS Capability Handling in GERAN *Iu mode* agreed in GERAN WG2#6 bis meeting are the following:

- The MS capabilities of *Iu mode* capable MS are separated into GERAN *Iu mode* MS Radio Access Capabilities and CN Capabilities. The CN Capabilities are identical for GERAN *Iu mode* and UMTS while the GERAN *Iu mode* MS Radio Access Capabilities are new information elements based on existing GSM and GPRS capabilities.
- The CN capabilities (e.g. MS Classmarks, MS network capability) will be handled in the same way when the MS operates in *Iu mode* regardless if the MS is in UTRAN or GERAN.
- The GERAN *Iu mode* MS Radio Access Capabilities will only be handled by the GERAN and will be sent to the GERAN by the MS at RRC connection setup or when they are requested by the GERAN.
- Multi-mode and multi-RAT capable MS that operates in GERAN *Iu mode* will also send their GERAN A/Gb and UTRAN capabilities to the GERAN at RRC connection setup or when they are requested by the GERAN. These capabilities will later on be used if the MS performs an inter-mode or inter-RAT handover.

Reference
These principles are discussed in G2-020409, RRC drafting session, UK, May 2002.

4.7.2 MS Capability Information and Enquiry procedures

The MS capability enquiry can be used to request the MS to transmit its capability information related to any radio access network that is supported by the MS. The MS capability enquiry procedure is initiated by the GERAN by transmitting an MS CAPABILITY ENQUIRY message. This procedure is presented in the figure below.

Figure 27:MS capability enquiry procedure

The MS Capability Update procedure is used by the MS to convey MS specific capability information to the GERAN. The MS shall initiate the MS Capability Update procedure in the following situations:

- When the MS receives a MS Capability Enquiry message from the GERAN or while in RRC-Connected mode
- The MS capabilities changes.

The MS uses the MS capability update procedure is presented in figure below.

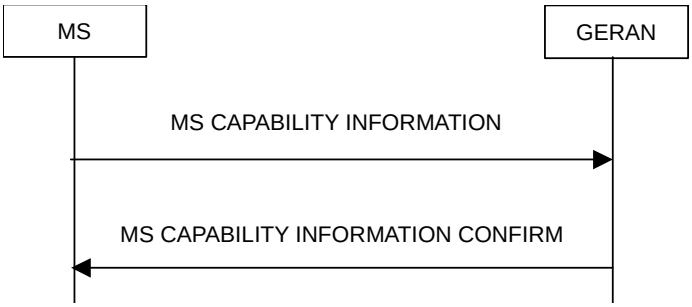


Figure 28: Transmission of MS capability information

If the MS CAPABILITY INFORMATION message is sent in response to a MS CAPABILITY ENQUIRY message, the MS shall include also information about the GERAN *A/Gb mode* capabilities and UE UTRAN capabilities or UE CDMA2000 capabilities.
Also the predefined configuration information can be obtained with this procedure and this information would be used for handover to UTRAN. The same capability is defined in GSM procedures defined in 3GPP TS 44.018, sections 3.4.10 and 3.4.11.

Reference
The procedures are described in 3GPP TS 44.118, section 7.6.

4.8 LCS procedures

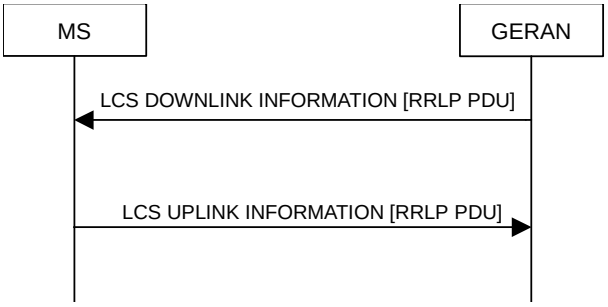


Figure 29: LCS transfer

The LCS Transfer procedure enables the SMLC on the network side and the MS to exchange RRLP Protocol Data Units (PDUs). Only the GERAN may initiate the exchange of RRLP PDU's (initiated by the SMLC). The MS only sends RRLP PDU's in the uplink direction in response to RRLP PDU's sent by the GERAN (SMLC).

The maximum size of the RRLP PDU in the LCS DOWNLINK INFORMATION and LCS UPLINK INFORMATION messages is 242 octets. Since RRLP pseudo segmentation limits the length of RRLP PDUs, segmentation is not defined for the LCS Transfer procedure.

The procedures are described in 3GPP TS 44.118,7.13.

4.9 RRC connection mobility

4.9.1 Cell and GRA Update procedures

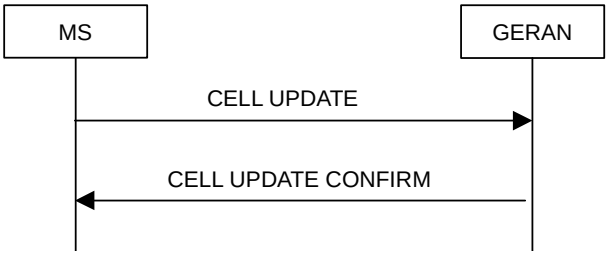


Figure 30: Cell Update procedure, basic flow

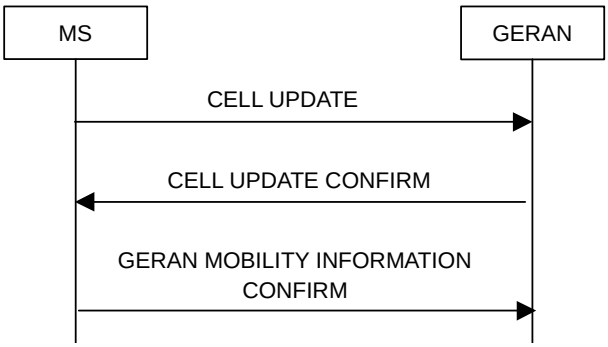


Figure 31: Cell Update procedure with update of GERAN mobility information

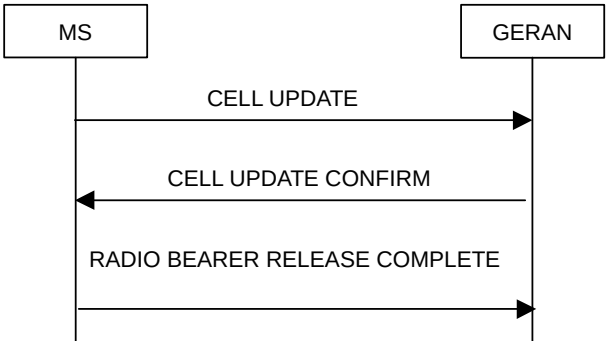


Figure 32: Cell Update procedure with radio bearer release

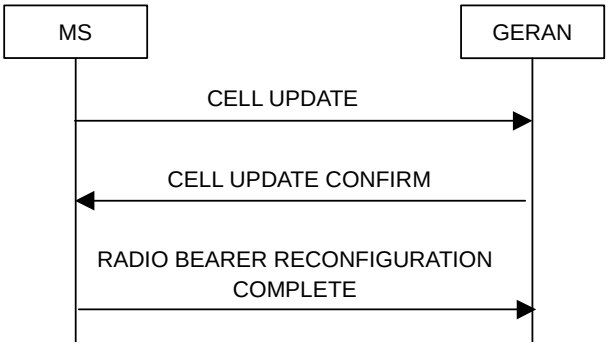


Figure 33: Cell Update procedure with radio bearer reconfiguration

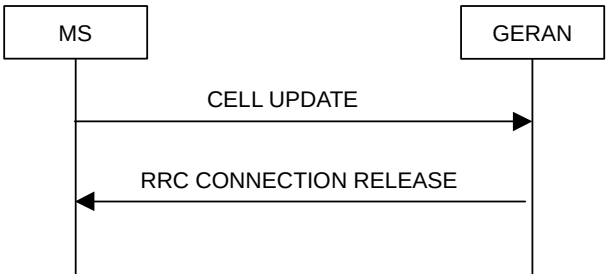


Figure 34: Cell Update procedure, failure case

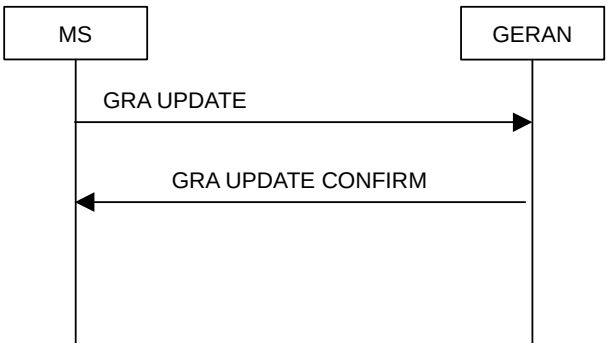


Figure 35: GRA Update procedure, basic flow

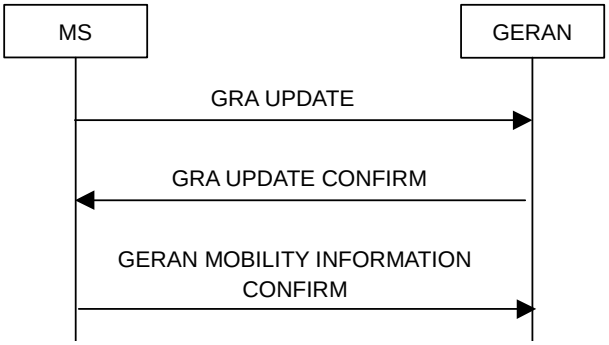


Figure 7.8.1.7/3GPP TS 44.11

Figure 36: GRA Update procedure with update of GERAN mobility information

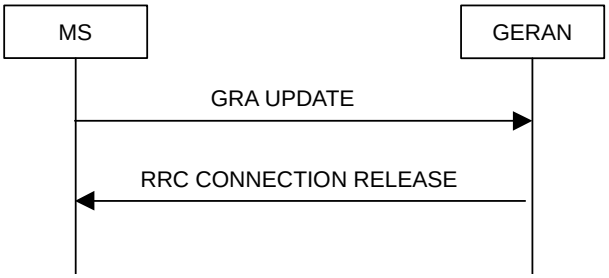


Figure 37: GRA Update procedure, failure case

The GRA Update and Cell Update procedures serve several main purposes:

- To notify GERAN of an RLC unrecoverable error (see 3GPP TS 44.160) on an AM RLC entity;
- To be used as a supervision mechanism in the RRC-Cell_Shared state or RRC-GRA_PCH state by means of periodical update;

In addition, the GRA Update procedure also serves the following purpose:

- To retrieve a new GRA identity after cell re-selection to a cell not belonging to the current GRA assigned to the MS in RRC-GRA_PCH state;

In addition, the Cell Update procedure also serves the following purposes:

- To update GERAN with the current cell the MS is camping on after cell reselection;
- To act on a radio link failure or notification of invalid RLC/MAC control message in the RRC-Cell_Dedicated state;
- To act on the transmission failure of the MS CAPABILITY INFORMATION message;
- When triggered in the RRC-GRA_PCH state, to notify GERAN of a transition to the RRC-Cell_Shared state due to the reception of GERAN originated paging or due to a request to transmit uplink data.

The GRA Update and Cell Update procedures may:

- Include an update of mobility related information in the MS;
- Cause a state transition from the RRC-Cell_Shared state to the RRC-Cell_Dedicated state, or from RRC-GRA_PCH state to RRC-Idle mode.

The Cell Update procedure may also include:

- A re-establish of layer 2, AM RLC entities;
- A radio bearer release, or radio bearer reconfiguration;

- A DBPSCH assignment.

A MS shall initiate the Cell Update procedure in the following cases:

- Uplink data transmission:
    - If the MS is in RRC-GRA_PCH state; and
    - If the MS has uplink signalling or data to transmit except a GRA UPDATE message;
        - Perform cell update using the cause "uplink data transmission".
- Paging response:
    - If the MS in RRC-GRA_PCH state or RRC-Cell_Shared state, receives paging information from the lower layers fulfilling the conditions for initiating a Cell Update procedure specified in subclause 7.4, 3GPP TS 44.118:
        - Perform cell update using the cause "paging response".
- Radio link failure:
    - If the MS is in RRC-Cell_Dedicated state; and the criteria for radio link failure is met as specified in subclause 7.18, 3GPPTS 44.118; or
    - If the criteria for radio link failure is met as specified in sub-clause 7.18, 3GPP 44.118 the transmission of the MS CAPABILITY INFORMATION message fails as specified in subclause 7.6.6, 3GPP TS 44.118:
        - Perform cell update using the cause "radio link failure".
- Invalid RLC/MAC control message:
    - If the MS is in RRC-Cell_Dedicated state; and
    - If notification is received of the reception of an invalid RLC/MAC control message on DBPSCH:
        - Perform cell update using the cause "invalid RLC/MAC control message".
- RLC unrecoverable error:
    - if none of the criteria for performing cell update with the causes specified above in the current sub-clause is met; and
    - if the MS detects an RLC unrecoverable error (see 3GPP TS 44.160) in an AM RLC entity:
        - perform cell update using the cause "RLC unrecoverable error".
- Cell reselection:
    - If the MS is in RRC-Cell_Shared state; and
    - If the MS performs cell re-selection:
        - Perform cell update using the cause "cell reselection".
- Periodical cell update:
    - If the MS is in RRC-Cell_Shared state; and
    - If the timer T305 expires; and
    - If periodic updating has been configured by T305 in the IE "MS Timers and Constants in Connected mode" set to any other value than "infinity":
        - Perform cell update using the cause "periodical cell update".

Periodical cell updates are initiated if the MS is in RRC GRA-Cell_Shared state and tries to renew the information that it is still present in the network.

A MS in RRC-GRA_PCH state shall initiate the GRA Update procedure in the following cases:

- GRA reselection:
  - If the MS detects that the current GRA assigned to the MS, stored in the variable GRA_IDENTITY, is not present in the list of GRA identities in packet system information 16; or
  - If the list of GRA identities in packet system information 16 is empty; or
  - If the packet system information 16 can not be found:
    - Perform GRA update using the cause "change of GRA".
- Periodic GRA update:
  - If the timer T305 expires while the MS is in RRC-GRA_PCH state; and
  - If periodic updating has been configured by T305 in the IE "MS Timers and Constants in Connected mode" set to any other value than "infinity":
    - Perform GRA update using the cause "periodic GRA update".

The Cell Update procedures and GRA update procedures are described in stage 3 3GPP TS 44.118, 7.8.1 and 7.8.2.
GERAN Mobility Information procedures are used to change the G-RNTI or other mobility information to MS. It is network initiated. At the MS side the procedure is finished when the MS changes to the new configuration and sends GERAN Mobility Information Complete message to the network. In case that it is unsuccessful configuration, the failure message is sent.

Reference
The procedures are described in 3GPP TS 44.118, 7.8.3.

4.10 Delivery of Non-Access stratum messages

4.10.1 Initial Direct transfer

Figure 38: Initial Direct transfer in the uplink, normal flow

The Initial Direct Transfer procedure is used in the uplink to establish a signalling connection. It is also used to carry an initial upper layer (NAS) messages over the radio interface. It is initiated by the MS.

4.10.2 Downlink Direct transfer

Figure 39: Downlink Direct transfer, normal flow

The Downlink Direct Transfer procedure is used in the downlink direction to carry upper layer (NAS) messages over the radio interface.

4.10.3 Uplink Direct transfer

Figure 40: Uplink Direct transfer, normal flow

The Uplink Direct Transfer procedure is used in the uplink direction to carry all subsequent upper layer (NAS) messages over the radio interface belonging to a signaling connection.

Reference
These procedures are described in 3GPP TS 44.118, section 7.17.

4.11 Signaling connection release indication procedure

Figure 41: Signaling Connection Release procedure, normal case

The Signalling Connection Release procedure is used to notify to the MS that one of its ongoing signalling connections has been released. The procedure does not initiate the release of the RRC connection.

Figure 42: Signaling Connection Release Indication procedure, normal case

The Signalling Connection Release Indication procedure is used by the MS to indicate to the GERAN that one of its signalling connections has been released. The procedure may in turn initiate the RRC connection release procedure.

Reference
These procedures are described in 3GPP TS 44.118, section 7.15.

4.12 Measurements

In GERAN *Iu mode* the same mechanism as in GERAN *A/Gb mode* is considered (see 3GPP TS 44.118, sub-clause 7.9). In RRC-Cell_Dedicated state, the mobile station sends measurement report messages and receives system information on SRB1. In the uplink direction, measurement report messages are sent using SRB1 at each possible occasion when no other RRC message has to be sent (see sub-clause 7.9.2, 3GPP TS 44.118). Similarly, in the downlink direction, SYSTEM INFORMATION TYPE 5, 6 and optionally 5bis and 5ter messages are sent on SRB1 when no other RRC message has to be sent. The network may, in addition, send MEASUREMENT INFORMATION messages on SRB1 to a mobile station in RRC-Cell_Dedicated state. This message may order the MS to use the enhanced measurement reporting. The mapping of SRB1 onto logical channels is specified in 3GPP TS 44.160 sub-clause 5.6.
A mobile station with extended measurement capabilities, which receives EXTENDED MEASUREMENT ORDER messages on SRB1, shall perform and report extended measurements, see sub-clause 7.9.3, 3GPP TS 44.118.

Reference
These procedures are described in 3GPP TS 44.118, section 7.9.

4.13 CSN-1 coding is used for RRC messages

The coding of the RRC messages, Informatio Elements and variables is done in CSN-1 (see 3GPP TS44.118 sections 8, 9, 10 and 11).

5. LIST OF THE RRC MESSAGES

The complete list of the RRC messages is in section 9.2, 3GPP TS 44.118.

6. REFERENCES

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

For a specific reference, subsequent revisions do not apply.

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

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

[2] 3GPP TS 22.011: "Service accessibility".

[3] 3GPP TS 23.003: "Numbering, addressing and identification".

[4] 3GPP TS 23.022: "Functions related to Mobile Station (MS) in idle mode".

[5] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service Description; Stage 2".

[6] 3GPP TS 23.101: "General UMTS Architecture".

[7] 3GPP TS 23.110: " UMTS Access Stratum; Services and Functions".

[8] 3GPP TS 23.221: "Architectural requirements".

[9] 3GPP TS 24.002: "GSM Public Land Mobile Network (PLMN) access reference configuration".

[10] 3GPP TS 24.007: "Mobile radio interface signalling layer 3; General aspects".

[11] 3GPP TS 24.008: “Mobile radio interface layer 3 specification;Core Network Protocols - Stage 3”

[12] 3GPP TS 24.010: "Mobile radio interface layer 3 Supplementary services specification; General aspects".

[13] 3GPP TS 24.011: "Point-to-point (PP) Short Message Service (SMS) support on mobile radio interface".

[14] 3GPP TS 24.080: "Mobile radio interface layer 3 supplementary services specification Formats and coding".

[15] 3GPP TS 25.323: "Packet Data Convergence Protocol (PDCP) Specification".

[16] 3GPP TS 25.331: "Radio Access Network; RRC Protocol Specification".

[17] 3GPP TS 31.102: "Characteristics of the USIM Application".

[18] 3GPP TS 33.102: "3G Security; Security Architecture".

[19] 3GPP TS 43.013: "Discontinuous Reception (DRX) in the GSM system".

[20] 3GPP TS 43.051: "Radio Access Network; Overall description Stage 2".

[21] 3GPP TS 43.059: "Functional Stage 2 Description of Location Services in GERAN".

[22] 3GPP TS 44.004: "Layer 1 General requirements".

[23] 3GPP TS 44.005: "Data Link (DL) layer General aspects".

[24] 3GPP TS 44.006: "Mobile Station - Base Station System (MS - BSS) interface Data Link (DL) layer specification".

[25] 3GPP TS 44.003: "Mobile Station Base Station System (MS - BSS) interface Channel structures and access capabilities".

[26] 3GPP TS 44.012: "Short Message Service Cell Broadcast (SMSCB) support on the mobile radio interface".

[27] 3GPP TS 44.018:" GSM EDGE Radio Access Network, Mobile radio interface layer 3 specification, Radio Resource Control Protocol"

[28] 3GPP TS 44.031: "Location Services;Mobile Station (MS) – Serving Mobile Location Centre (SMLC); Radio Resource LCS Protocol (RRLP)".

[29] 3GPP TS 44.071: "Mobile radio interface layer 3 location services specification.

[30] 3GPP TS 44.060: "General Packet Radio Service (GPRS); Mobile Station - Base Station System (MS-BSS) interface; Radio Link Control and Medium Access Control (RLC/MAC) layer specification".

[31] 3GPP TS 44.160: "General Packet Radio Service (GPRS); Mobile Station - Base Station System (MS-BSS) interface; Radio Link Control and Medium Access Control (RLC/MAC) layer specification, Iu mode".

[32] 3GPP TS 45.002: "Multiplexing and multiple access on the radio path".

[33] 3GPP TS 45.005: "Radio transmission and reception".

[34] 3GPP TS 45.008: "Radio subsystem link control".

[35] 3GPP TS 45.010: "Radio subsystem synchronization".

[36] 3GPP TS 51.010: "Mobile Station (MS) conformity specification".

[37] ITU-T Recommendation Q.931: ISDN user-network interface layer 3 specification for basic control".

[38] TIA/EIA/IS-2000-5-A: "Upper Layer (Layer 3) Signaling Standard for cdma2000 Spread Spectrum Systems".

[39] TIA/EIA/IS-833: "Multi-Carrier Specification for Spread Spectrum Systems on GSM MAP (MC-MAP) (Lower Layers Air Interface)".

[40] TIA/EIA/IS-2000-4-A: "Signaling Link Access Control (LAC) Standard for cdma2000 Spread Spectrum Systems".

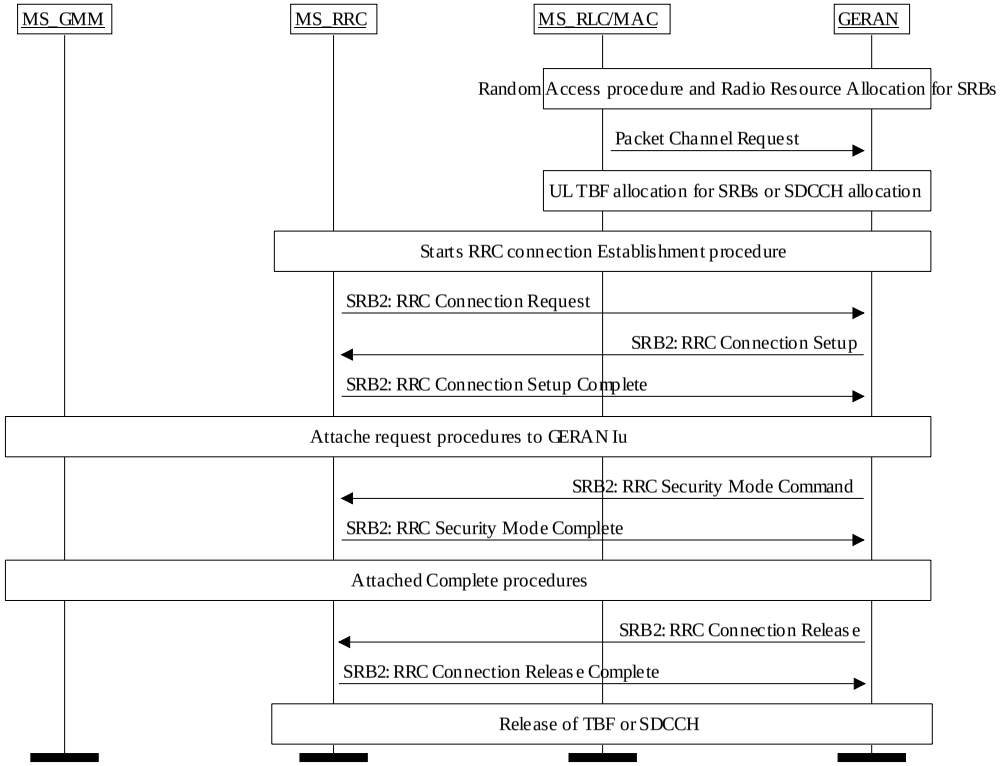
[41] Michel MOULY, “CSN.1 Specification, Version 2.0”, Cell & Sys, ISBN: 2-9510062-0-9. Web: http://perso.wanadoo.fr/cell.sys/.

6.1 CRs approved to other specifications

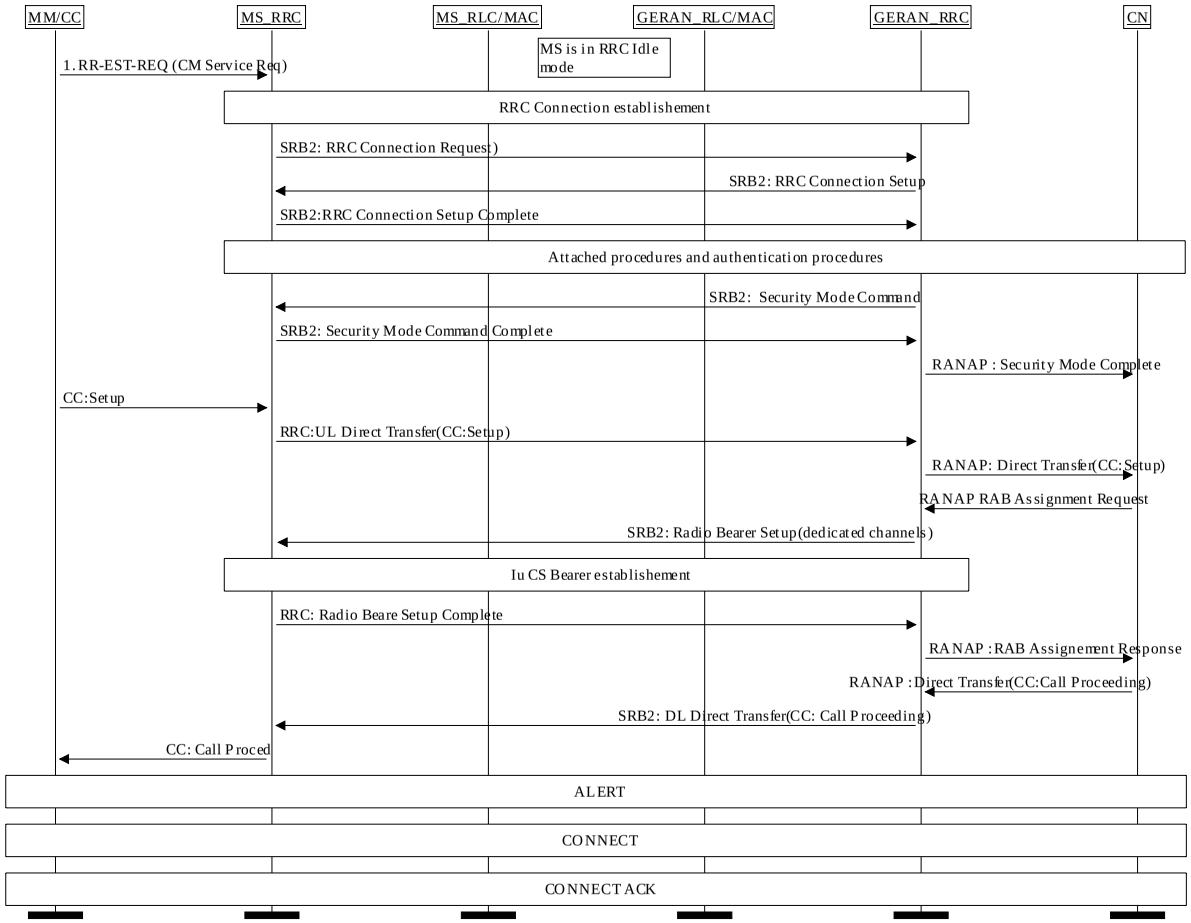
3GPP TS	TSG #	TSG Doc.	CR	Rev	Subject/Comment	version
44.018	GP#10	GP-021992	182	3	Intermode handover to GERAN Iu mode procedure	5.6.0
	GP#10	GP-021705	180	1	Alignment of measurement reporting with 44.118	5.6.0
	GP#10	GP-021706	181	1	Description of SI13alt	5.6.0
	GP#11	GP-022785	196	2	Addition of GERAN IU MODE CLASSMARK CHANGE message	5.7.0
	GP#12	GP-022932	225	3	Addition of GERAN Iu Mode Support Indication in SI4, SI7 and SI8	5.8.0
43.059	GP#08	GP-020493	026	2	Stage 2 Updates for Iu Mode LCS	5.2.0
23.060	SA#15	SP-020131	287	4	General changes for GERAN Iu mode	5.1.0
	SA#14		276 r4		Handover and Cell Reselection procedures for GERAN Iu mode	5.0.0
23.009	NP#16	NP-020243	074	1	Clarification that Multicall is not supported in GERAN Iu-mode	5.1.0
	NP#14	NP-010661	061		Reflection of RRC changes in 44.018 to 23.009	5.0.0
24.008	NP#17	NP-020384	643	2	GERAN Iu Mode Capability	5.5.0
25.413	RP#17	RP-020624	506	2	GERAN specific impacts on the Iu-cs interface	5.2.0
	RP#17	RP-020643	515		Signalling enhancements for GERAN Iu Mode LCS	5.2.0
25.423	RP#16	RP-020447	669	2	Support of Iur-g procedures (implemented after PCG endorsement)	5.2.0

ANNEX

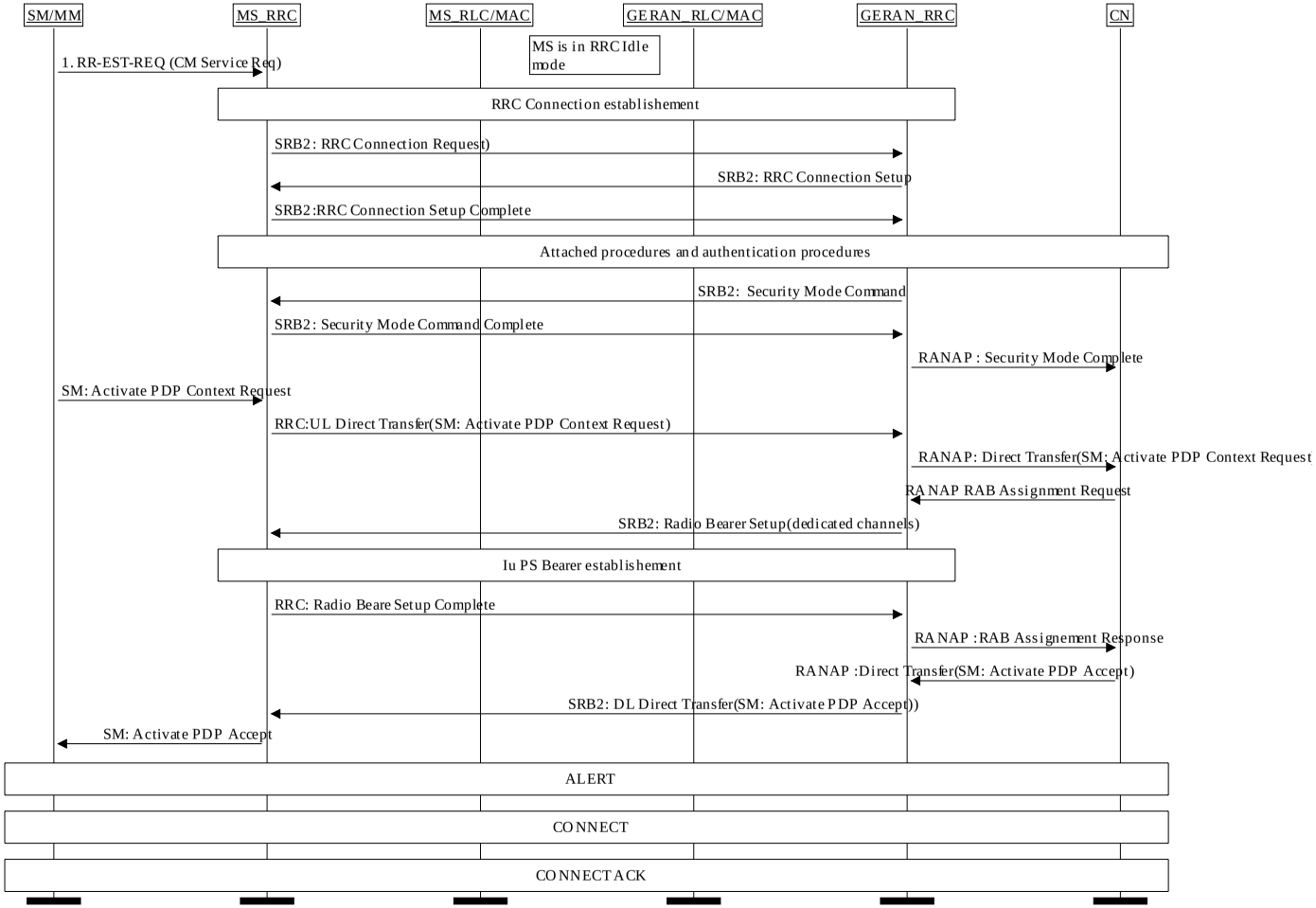
Registration to PS and CS domain



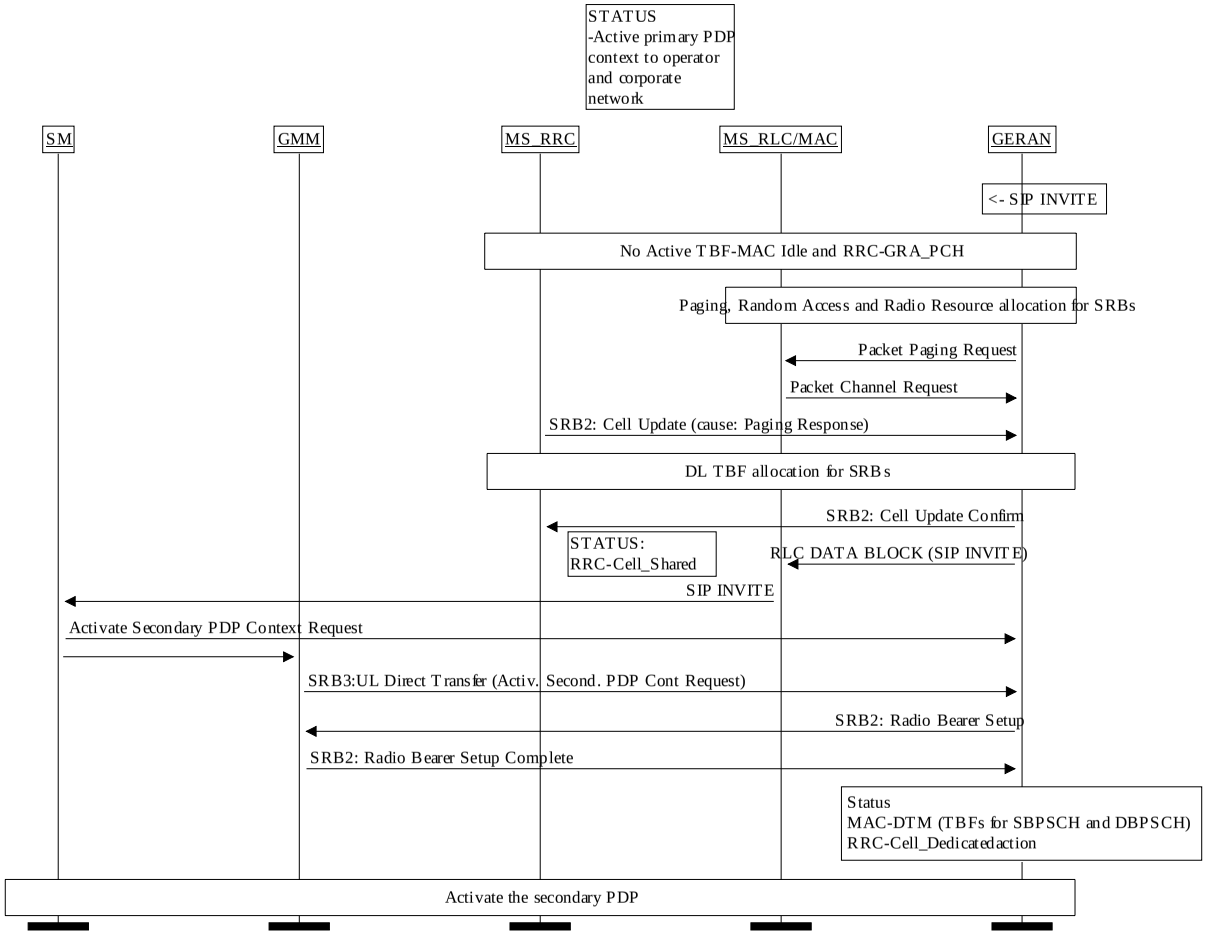
CS Call


MM/CC
MS_RRC
MS_RLC/MAC
GERAN_RLC/MAC
GERAN_RRC
CN
MS is in RRC Idle mode
1. RR-EST-REQ (CM Service Req)
RRC Connection establishement
SRB2: RRC Connection Request)
SRB2: RRC Connection Setup
SRB2:RRC Connection Setup Complete
Attached procedures and authentication procedures
SRB2: Security Mode Command
SRB2: Security Mode Command Complete
RANAP : Security Mode Complete
CC:Setup
RRC:UL Direct Transfer(CC:Setup)
RANAP: Direct Transfer(CC:Setup)
RANAP RAB Assignment Request
SRB2: Radio Bearer Setup(dedicated channels)
Iu CS Bearer establishement
RRC: Radio Beare Setup Complete
RANAP :RAB Assignement Response
RANAP :Direct Transfer(CC:Call Proceeding)
SRB2: DL Direct Transfer(CC: Call Proceeding)
CC: Call Proced
ALERT
CONNECT
CONNECT ACK

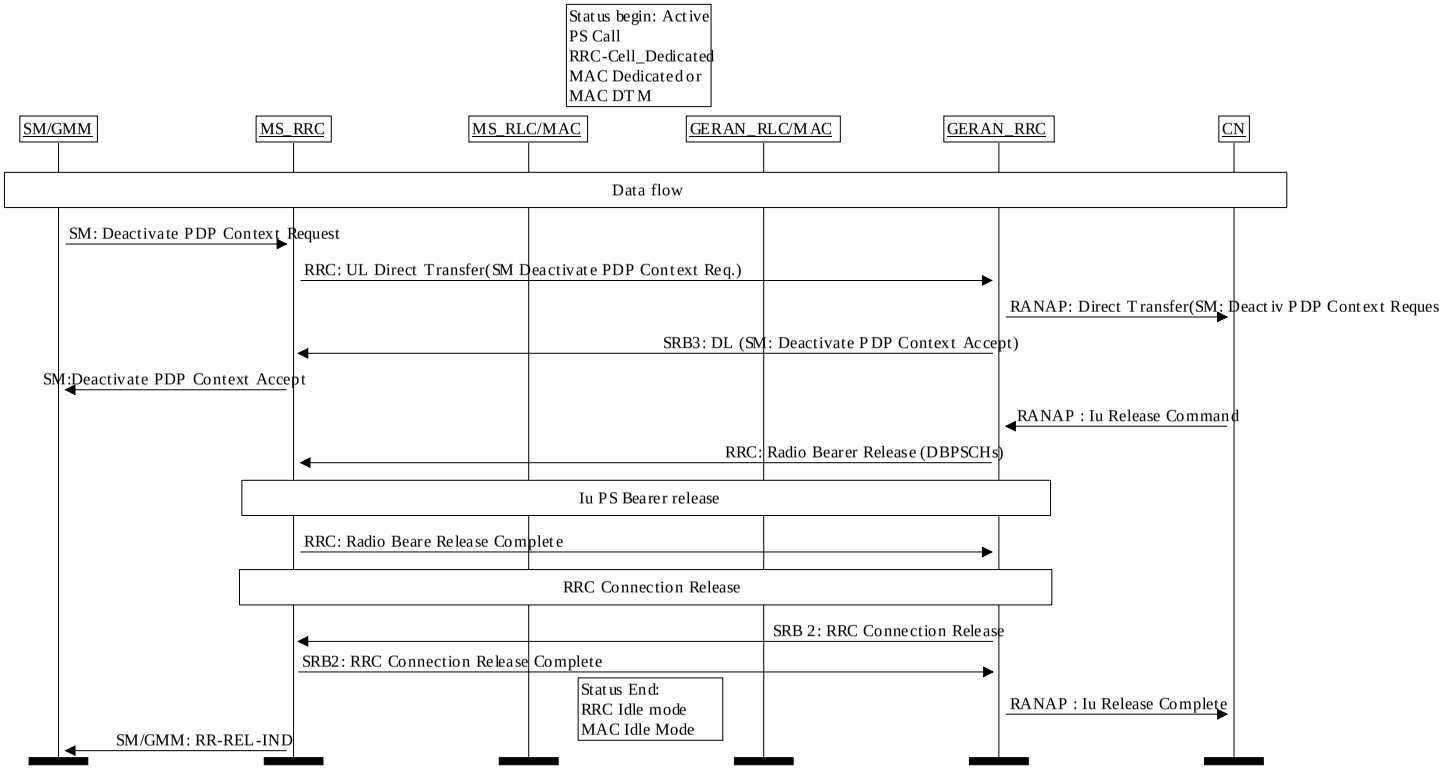
PS Call


SM/MM
MS_RRC
MS_RLC/MAC
GERAN_RLC/MAC
GERAN_RRC
CN
MS is in RRC Idle mode
1. RR-EST-REQ (CM Service Req)
RRC Connection establishement
SRB2: RRC Connection Request)
SRB2: RRC Connection Setup
SRB2:RRC Connection Setup Complete
Attached procedures and authentication procedures
SRB2: Security Mode Command
SRB2: Security Mode Command Complete
RANAP : Security Mode Complete
SM: Activate PDP Context Request
RRC:UL Direct Transfer(SM: Activate PDP Context Request)
RANAP: Direct Transfer(SM: Activate PDP Context Request
RANAP RAB Assignment Request
SRB2: Radio Bearer Setup(dedicated channels)
Iu PS Bearer establishement
RRC: Radio Beare Setup Complete
RANAP :RAB Assignement Response
RANAP :Direct Transfer(SM: Activate PDP Accept)
SRB2: DL Direct Transfer(SM: Activate PDP Accept))
SM: Activate PDP Accept
ALERT
CONNECT
CONNECT ACK

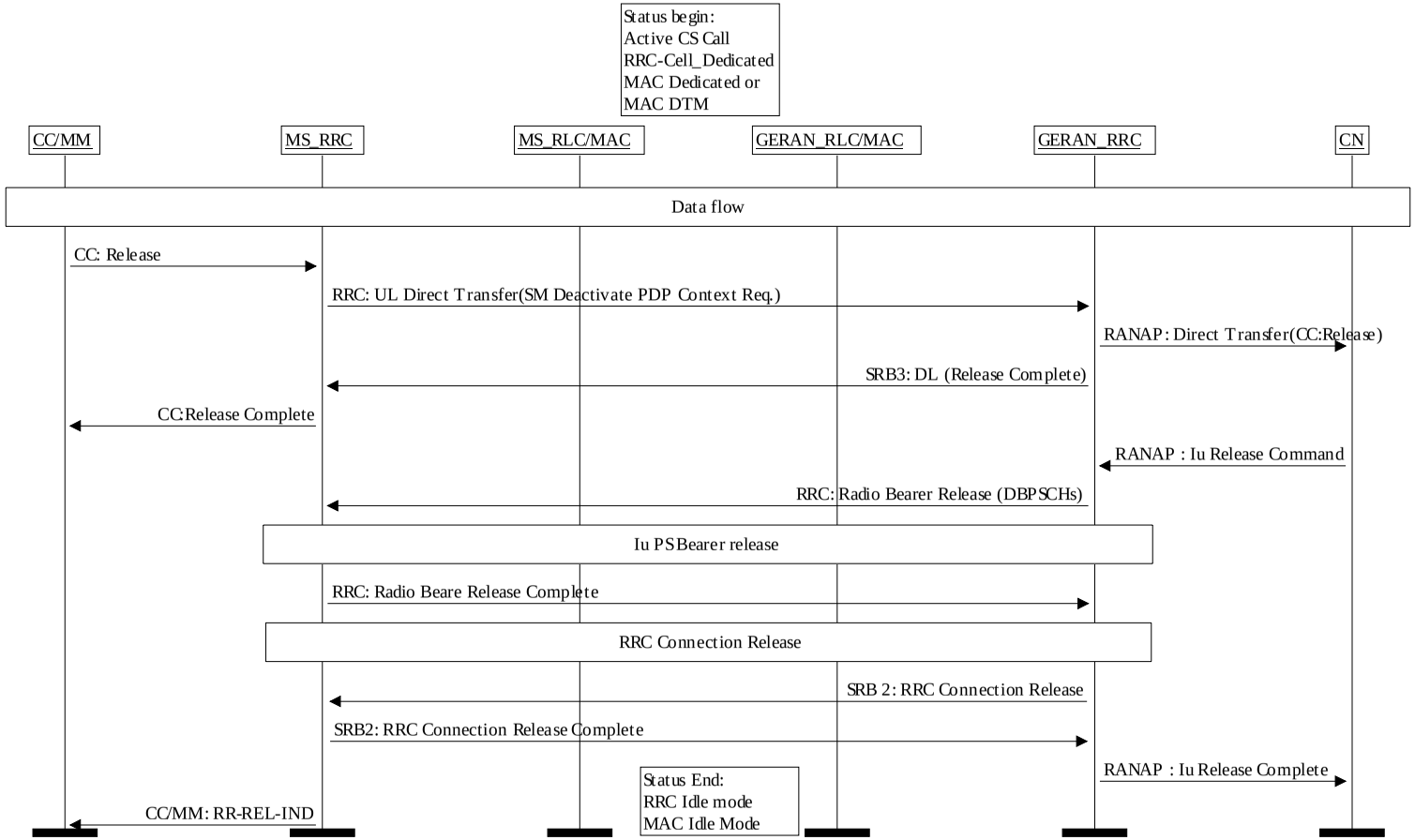
Answer to a PS call and continue simultaneously to surf the web



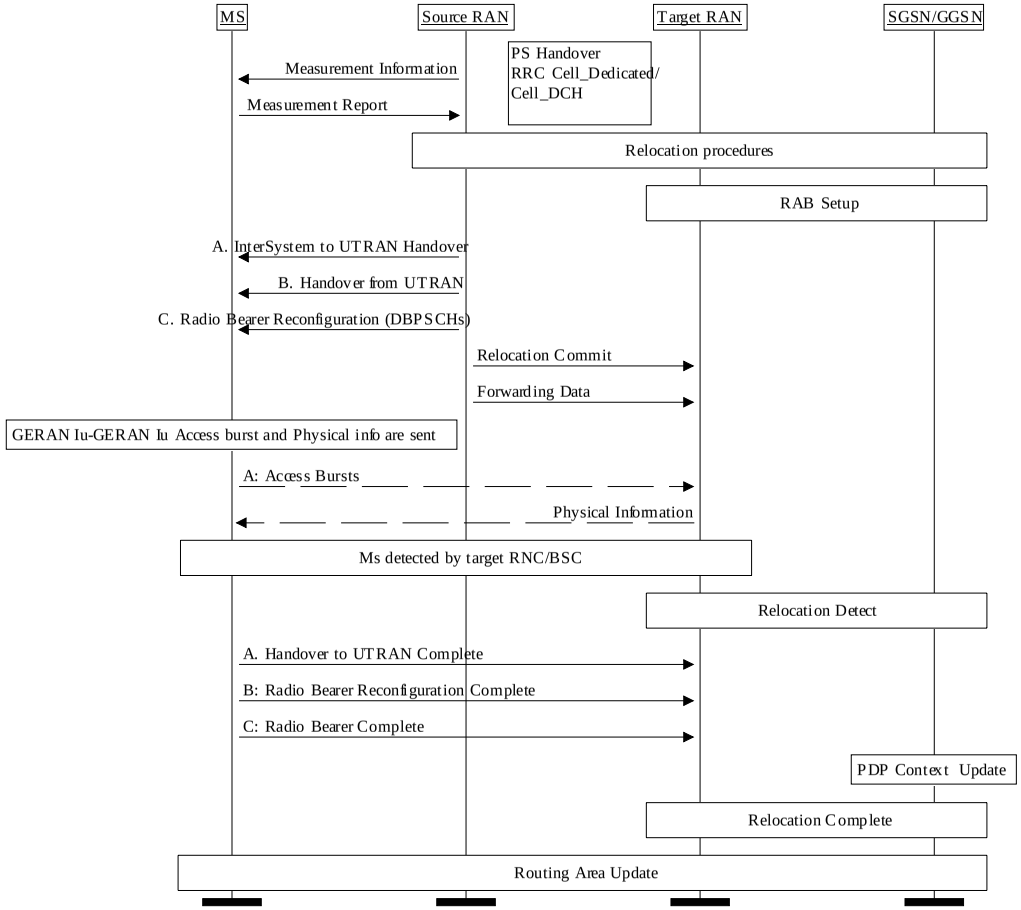
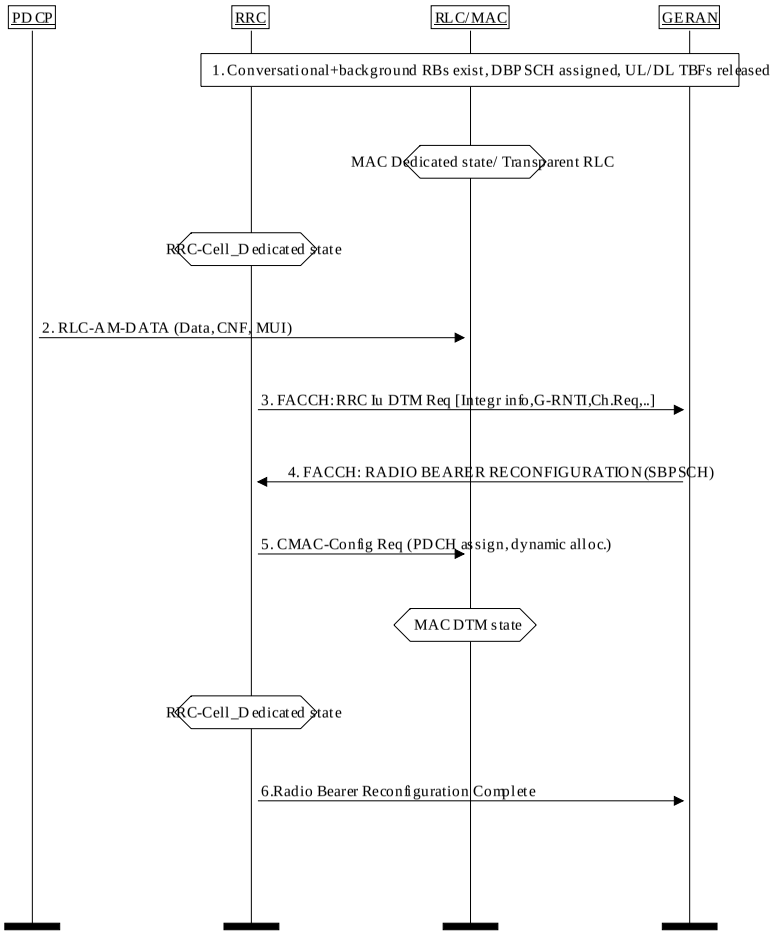
Session Release and RRC Connection Release



CS Call Release



PS Handover GERAN to GERAN, GERAN to UTRAN and UTRAN to GERAN



Initiation of uplink data transfer on SBPSCH using RRC signaling