UMTS Layer 3

UMTS Layer 3

1. RADIO RESOURCE CONTROL (RRC)

1.1 Introduction

RRC is located at Layer 3 in the control plane of the access stratum (AS). It resides in the UE and the UTRAN – at the Node B (UE in idle mode) or SRNC (UE in connected mode). RRC provides signalling transfer services to higher layers through service access points (SAP). Higher layer signalling messages are encapsulated within RRC messages for transmission over the radio interface. NAS higher layer entities using the services of RRC in this way are:

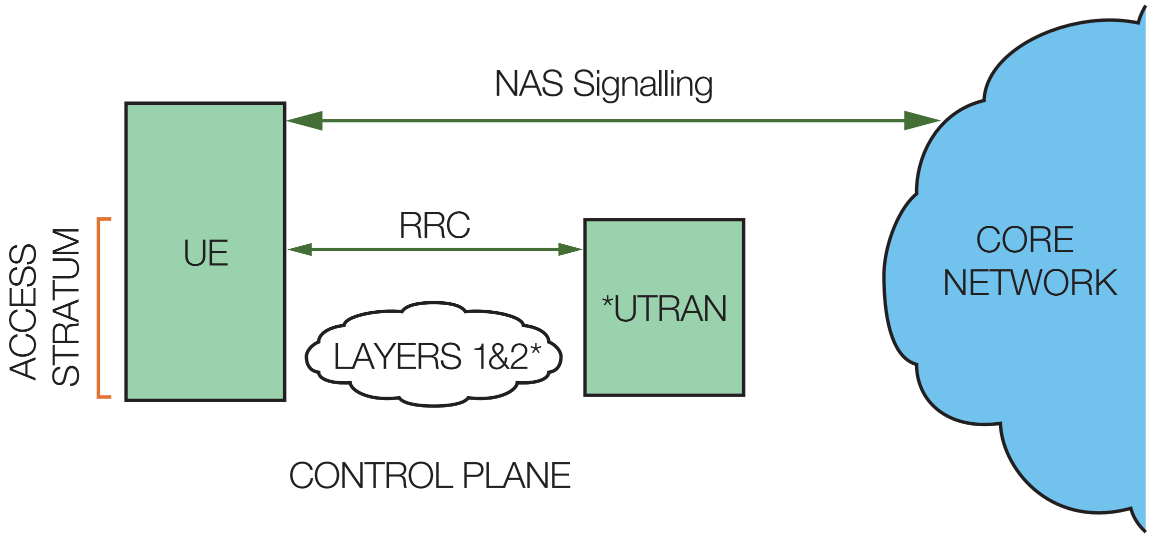
- Call Control (CC), which deals with set-up, maintenance and clear-down of circuit-switched calls.
- Session Management (SM), which deals with set-up, maintenance and clear-down of pocket-switched sessions.
- Mobility Management (MM), which deals with all mobility issues involving tracking of UEs as they move from area to area. Related to this is GPRS Mobility Management (GMM) which does the same for packet-mode operation.
- Short Message Service (SMS), dealing with SMS message delivery.

1.2 RRC Services

Three main forms of signalling transfer service offered to the higher layer entities are:

1) Broadcast Services, providing broadcast of System Information messages for example.
2) Paging and Notification Services.
3) Dedicated Control services to support the use of dedicated channels for connected mobiles.

- Broadcast services
- Paging and Notification services
- Dedicated Control services
- Encapsulation of NAS signalling (CC, SM, MM, GMM, SMS)



- Within the UTRAN, protocols terminate either at the Node B (idle mode) or SRNC (connected mode)

Fig. 1 – Radio Resources Control Services

1.3 RRC Functions

In order to provide the necessary services, a number of functions are performed within RRC. These are as follows:

- Broadcasting of signalling and control information, originating from both the access stratum (i.e. from the Node B or RNC) or the non-access stratum (the core network).
- Paging & notification, for one of three purposes:
  - the set-up of calls or sessions originating from the core network
  - changing the RRC state of a terminal
  - indicating changes in system information
- The establishment, maintenance and release of RRC connections. Only one (or zero) connection can exist between the UTRAN and any one terminal. Where multiple higher-layer signalling connections exist between the terminal and the core network, these will share a single RRC connection.
- The establishment, maintenance and release of radio bearers and resources, through control of transport and physical channels. Although the channel establishment services are actually performed in the lower layers, RRC provides control by means of its control interfaces to these layers.
- Various mobility functions, including tracking the user terminal's location, performing various handover functions, cell updates and terminal identification updates.
- Initial cell selection & re-selection in Idle mode.
- Downlink Outer loop power control (setting Signal to Interference Ratio targets), and open loop power control (initial power estimates).
- Arbitration of radio resources shared between multiple users on the uplink dedicated channel.
- Management of radio resources between the different cells.
- Routing of higher layer packet data units, for example, messages related to mobility, session and connection management.
- Control of security functions (ciphering & deciphering) performed in the RLC or MAC layers.
- Control of congestion.

- Broadcasting Control Information
- Paging and Notification
- Establishment, maintenance and release of RRC Connection
- Control of Transport and Physical Channel resources
- Mobility functions
- Cell selection and re-selection in Idle Mode
- Downlink Outer and Open Loop power control
- Radio Resource Arbitration between users
- Radio Resource Management between cells
- Routing Non-Access Stratum data
- Control of RLC & MAC Security functions
- Congestion Control
- QoS Control
- Integrity Protection of signalling messages
- Control of terminal measurement reporting
- Timing Advance in TDD mode
- Various ODMA mode functions

Fig. 2 – RRC Functions

- QoS control
- Integrity protection of signalling messages, using a check-sum algorithm.
- Control of terminal measurement reporting, i.e. letting it know what to report and when, and forwarding of these reports to the RNC.
- Optional timing advance in TDD mode, used to avoid interference between consecutive timeslots in large TDD cells. Since other practical considerations mean that TDD is likely to be used only for small cells, this is unlikely to be used in practice.
- Various additional functions, such as slow dynamic channel allocation (DCA) & relay, which are relevant to the ODMA relay mode of operation.

- Broadcasting Control Information
- Paging and Notification
- Establishment, maintenance and release of RRC Connection
- Control of Transport and Physical Channel resources
- Mobility functions
- Cell selection and re-selection in Idle Mode
- Downlink Outer and Open Loop power control
- Radio Resource Arbitration between users
- Radio Resource Management between cells
- Routing Non-Access Stratum data
- Control of RLC & MAC Security functions
- Congestion Control
- QoS Control
- Integrity Protection of signalling messages
- Control of terminal measurement reporting
- Timing Advance in TDD mode
- Various ODMA mode functions

Fig. 2 – RRC Functions

2. RRC ARCHITECTURE

2.1 RRC Functional Entities

RRC is comprised of several interacting functional entities.

The Broadcast Control Functional Entity (BCFE) looks after the broadcast of System Information and there will be at least one instance of BCFE per cell.

The Paging and Notification Functional Entity (PNFE) deals with paging of idle UEs to set up incoming CS or PS calls and notification of UEs to be involved in a group call. Once again there will exist at least one instance of PNFE per cell.

The Dedicated Control Functional Entity handles all functions and signalling related to a single UE in connected mode. As such, there will be one instance of DCFE per connected UE. The Shared Control Functional Entity (SCFE) is used only for TDD mode and is used to control access to the USCH and DSCH.

Correct mapping between RRC FE and RLC SAPs is ensured by the Transfer Mode Entity (TME).

Similarly, the Routing Functional Entity ensures routing of information to the correct higher-layer protocol.

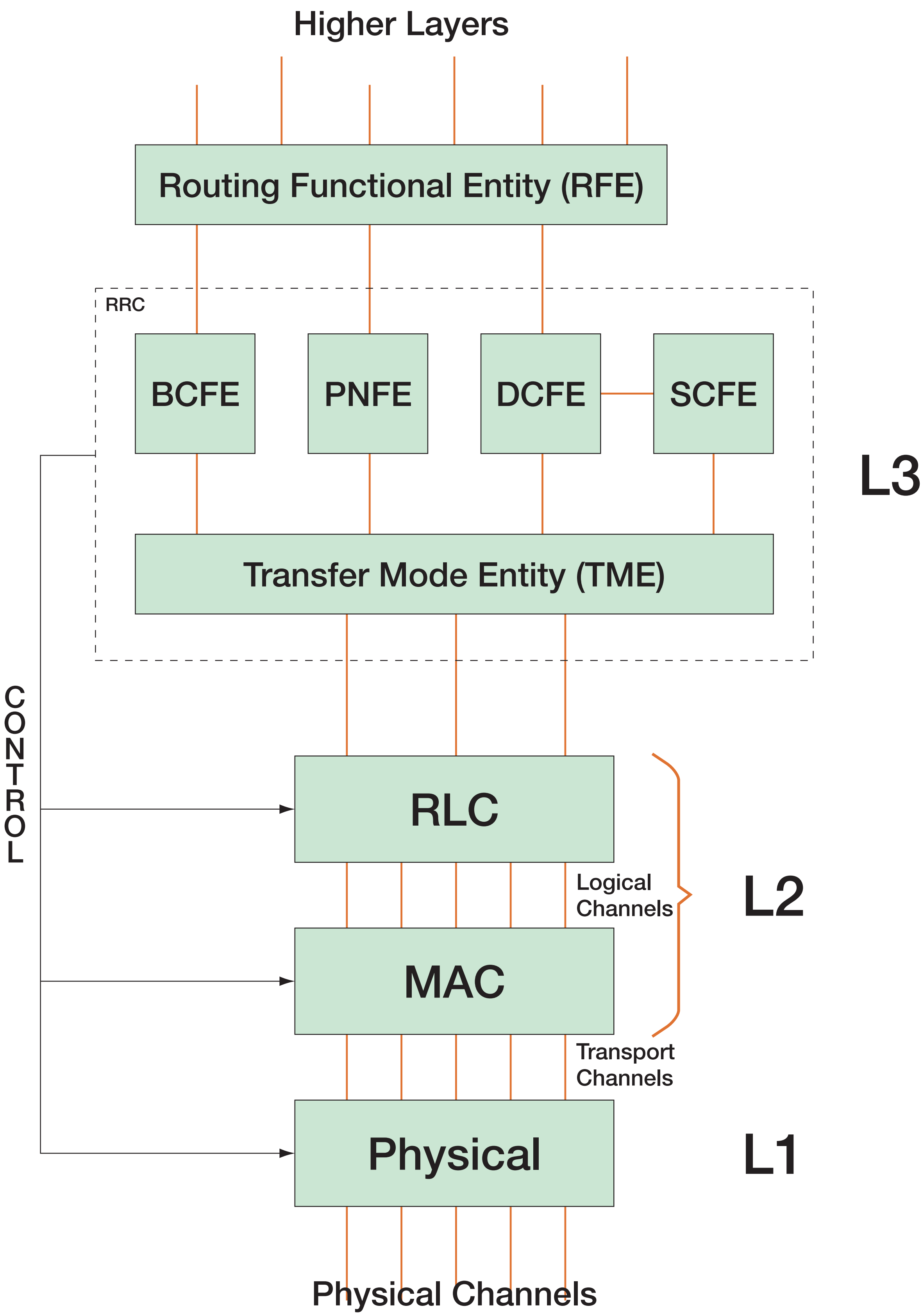


Fig. 3 – RRC Functional Entities

2.2 RRC Service Access Points

2.2.1 Access from Higher Layers

RRC provides three service access points (SAP) for higher layers. The General Control (GC) SAP to the services offered by BCFE.

PNFE is accessed via the Notification (Nt) SAP. The Dedicated Control (DC) SAP provides access to DCFE and for TDD mode, SCFE.

2.2.2 Utilisation of RLC SAPs

All three RLC service access points are utilised by RRC.

The TRM-SAP is used by all functional entities, as is the UM-SAP. Only the DCFE uses the AM-SAP.

The transfer mode entity (TME) implements these mappings.

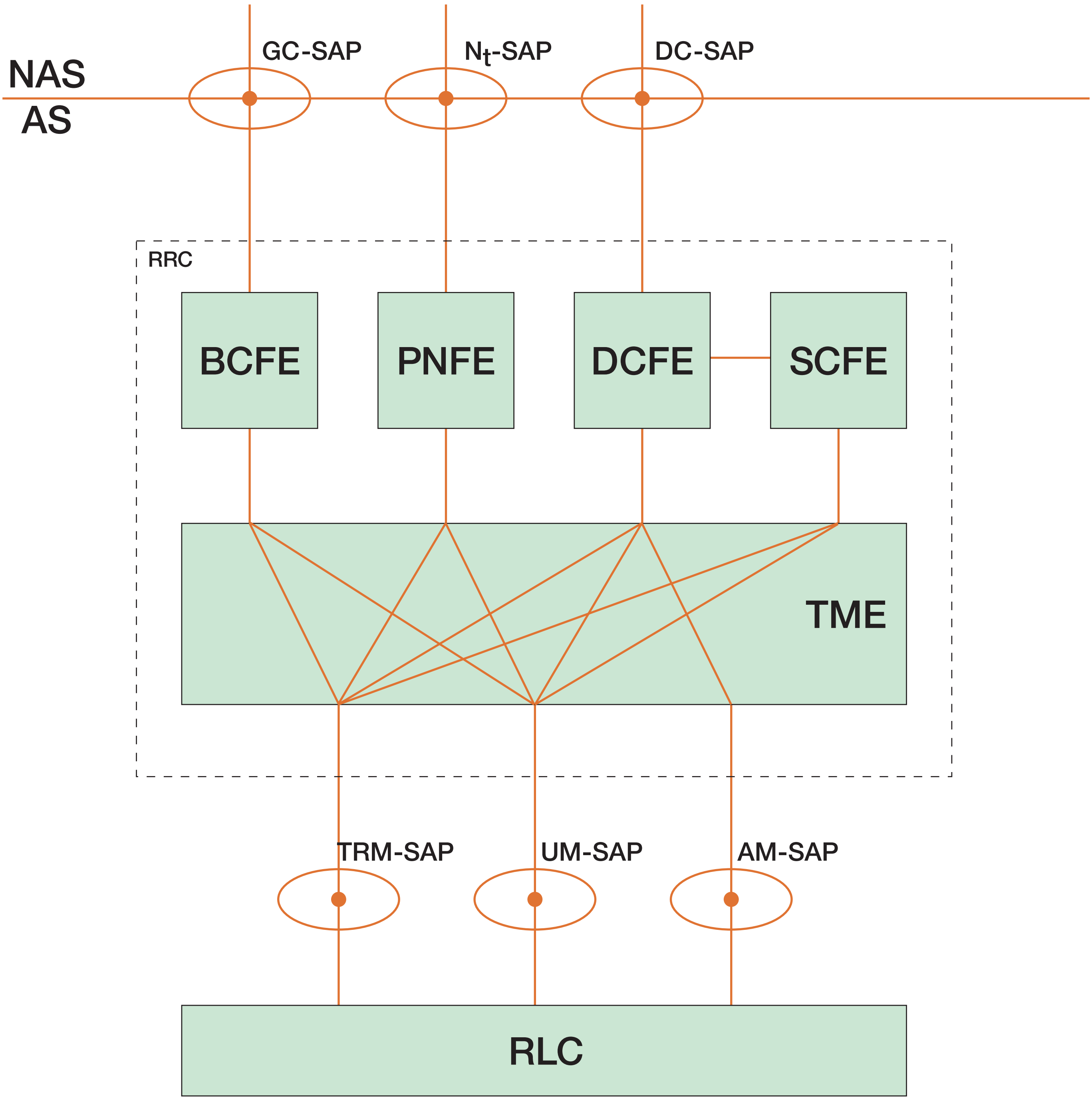


Fig. 4 – RRC Service Access Points

3. RRC SERVICE STATES

The two basic operational modes of a user terminal with respect to RRC are idle mode and connected (or dedicated) mode.

In idle mode, the peer entity of the RRC within the terminal is the RRC layer at the Node B, whereas in connected mode the peer entity is the RRC layer at the Serving RNC.

3.1 Idle Mode:

- After turning on its power, a terminal stays in idle mode until it transmits a request to establish a RRC connection. In this mode, the terminal can receive system information and cell broadcast messages.

It is identified by non-access stratum identities such as the IMSI (international mobile subscriber i.d.), or a TMSI (Temporary Mobile Subscriber I.D.) and the UTRAN has no information about the individual idle mode terminals. Therefore it can only address all such terminals in a cell by using a paging message.

3.2 Connected Mode

Connected mode, following the establishment of a RRC connection, can be further subdivided into service states, on the basis of the kind of channels the terminal is using.

Cell_DCH:

- A dedicated physical channel is allocated to the terminal, and the terminal is known by its serving RNC by means of a User Radio Network Temporary Identifier (U-RNTI) and a Cell RNTI (C-RNTI).

Cell_FACH:

- No dedicated physical channel is allocated to the terminal, and other common channels are instead used for transmitting signalling messages, plus small amounts of user data. The terminal can also listen to the broadcast system information, for general signalling messages.

  The terminal can perform cell reselections, sending a cell update message to the RNC and is identified by the C-RNTI on a cell level. Several terminals in a cell are separated within the MAC layer.

Cell_PCH:

- The user is only reachable via paging messages, and listens to the broadcast channel and to cell broadcast services. In case of a cell re-selection, the terminal will change to the Cell_FACH state in order to perform the cell change and inform the RNC and then fall back to Cell_PCH if no other activity is triggered. Since the paging channel includes a discontinuous reception functionality, the advantage of Cell_PCH is that battery consumption is less than in the Cell_FACH state.

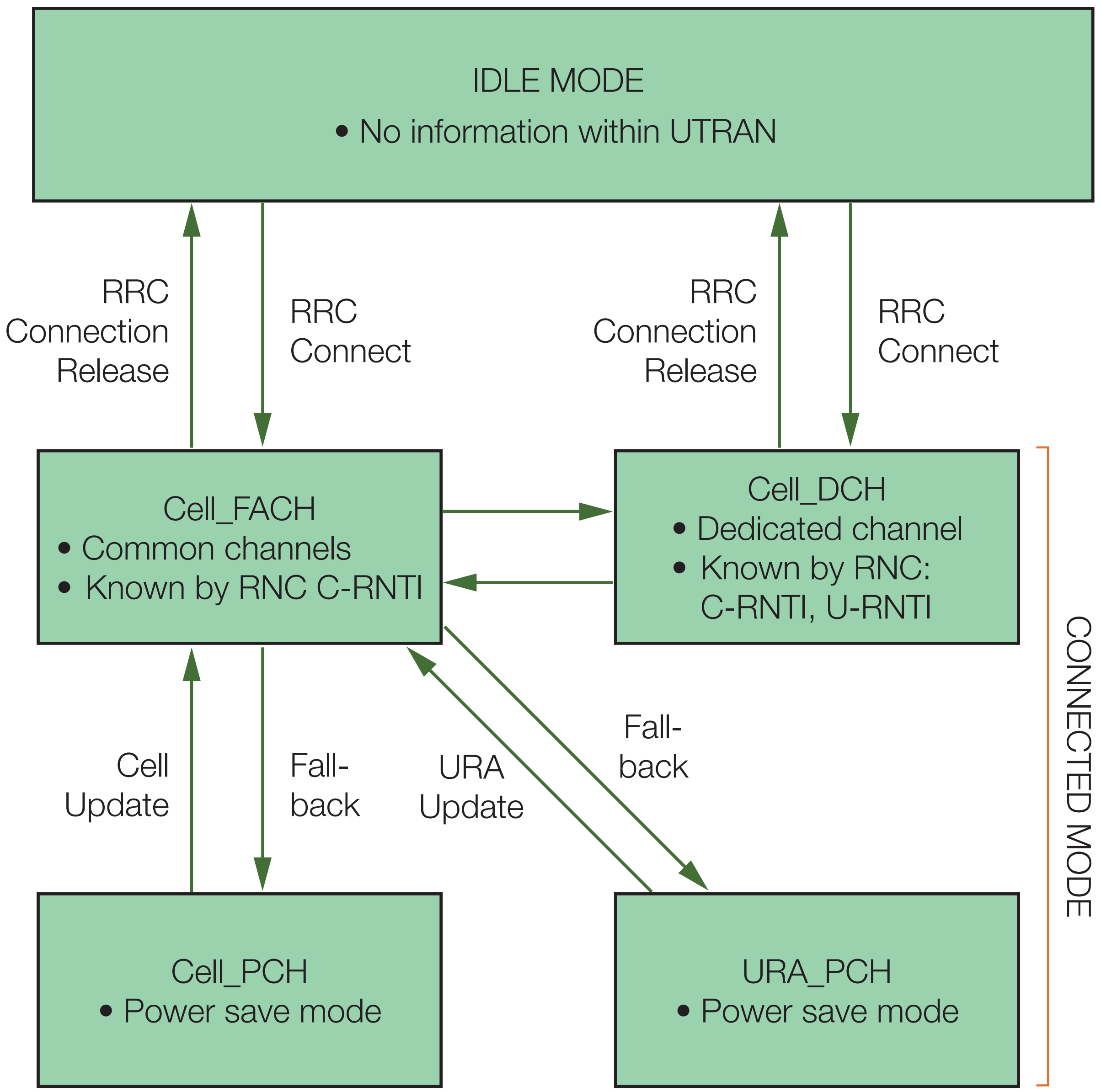


Fig. 5 – RRC Service States

URA_PCH is a similar mode to Cell_PCH, except that the terminal does not execute a cell update after each cell re-selection, but instead reads UTRAN Registration Area (URA) identities from the broadcast channel. Only if this URA changes does it need to inform the serving RNC.

A UE leaves one of these connected modes and returns to idle mode when the RRC connection is released or at a RRC connection failure.

* A dedicated channel is one whereby the identity of the user terminal is known simply on the basis of the channel itself (i.e. through unique allocation of the frequency, code and, if applicable, time slot). So an essentially point-to-point link exists between UTRAN and terminal. Connections other than Cell_DCH are based on common channels, ones intended for use by a number of users, and hence are point to multipoint. Signals intended for specific users within a common channel must be identified "in band".

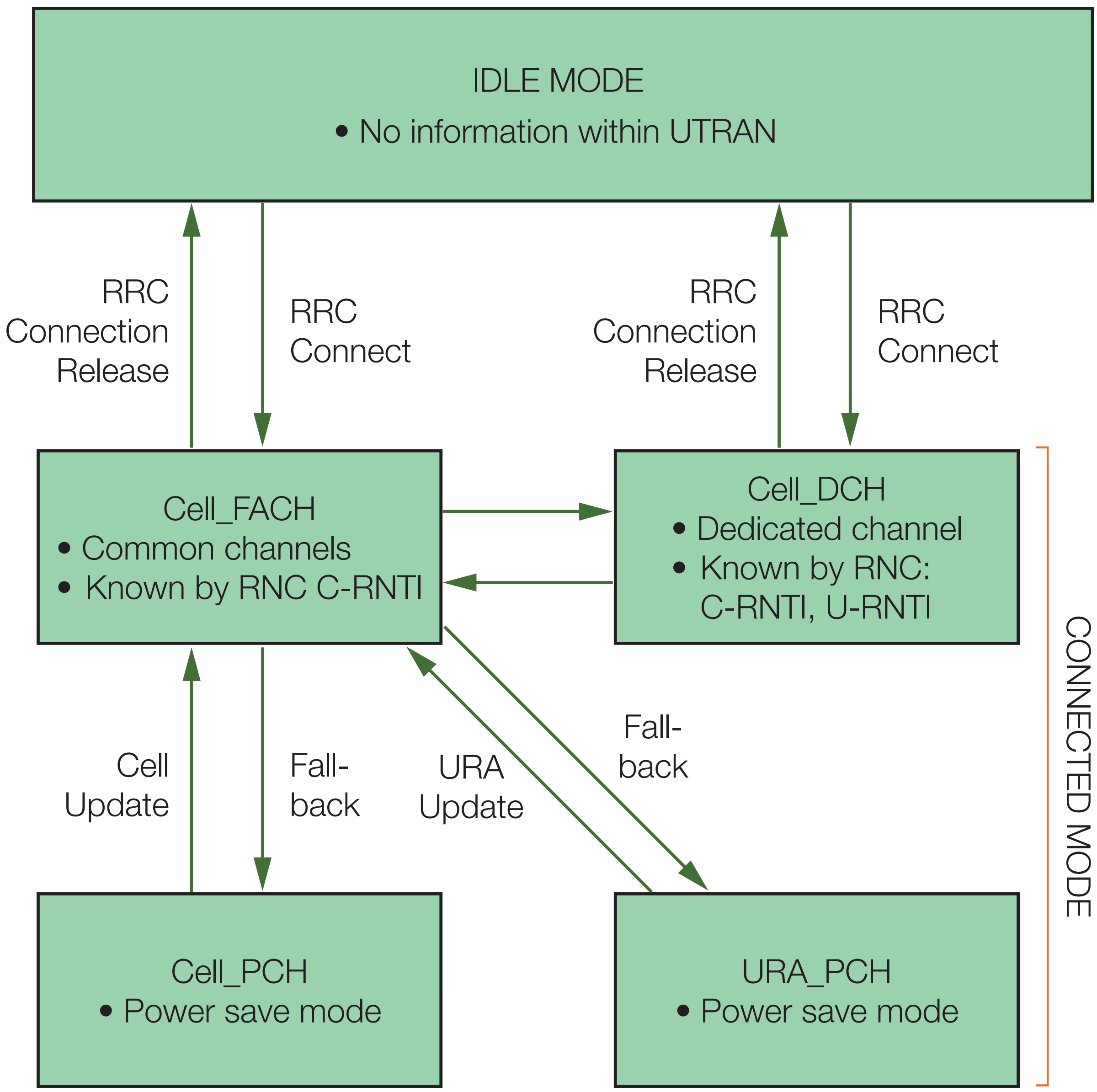


Fig. 5 – RRC Service States

4. USE OF RADIO NETWORK TEMPORARY IDENTIFIER (RNTI)

The 4 variants of Radio Network Temporary Identifier (RNTI) are used exclusively within the UTRAN to track UEs.

The Cell RNTI (c-RNTI) is assigned by the controlling RNC when a UE first accesses a cell and subsequently for all dedicated and common channel messages.

The serving RNC RNTI (S-RNTI) is allocated when a UE establishes an RRC connection within the UTRAN. The UE uses it to identify itself to the SRNC. Any drift RNC will use it to identify the UE to the serving RNC. The SRNC will also use it to address the UE.

The Drift RNC RNTI (d-RNTI) is used only over the IUR interface by the SRNC to identify the UE to a DRNC and maps to the corresponding S-RNTI.

The UTRAN RNTI (U-RNTI), a combination of S-RNTI and SRNC i.d., is used at first access at cell change and can be used by the controlling RNC to route uplink messages to the SRNC.

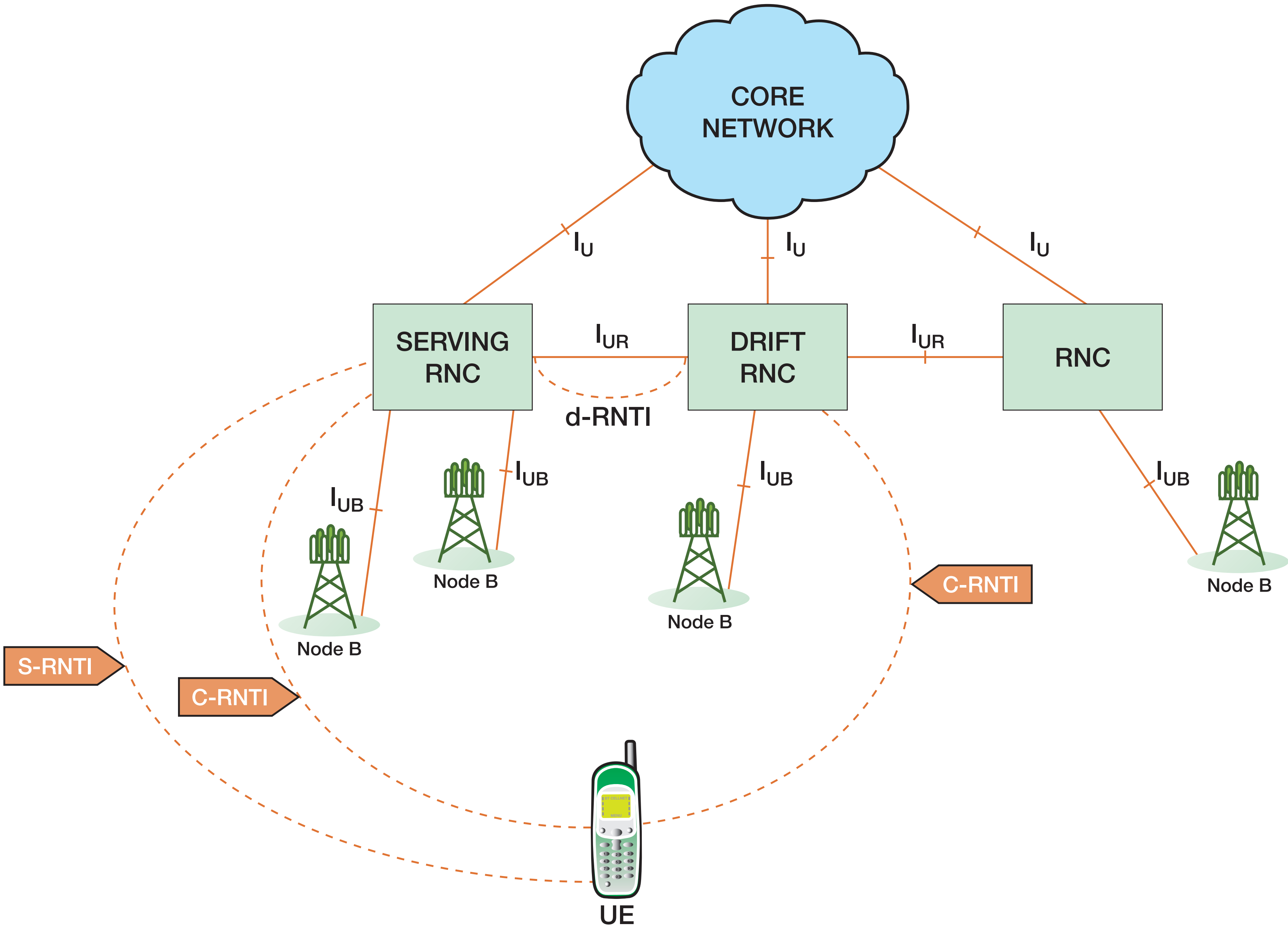


Fig. 6 – RNTI Usage

5. RRC PROCEDURES

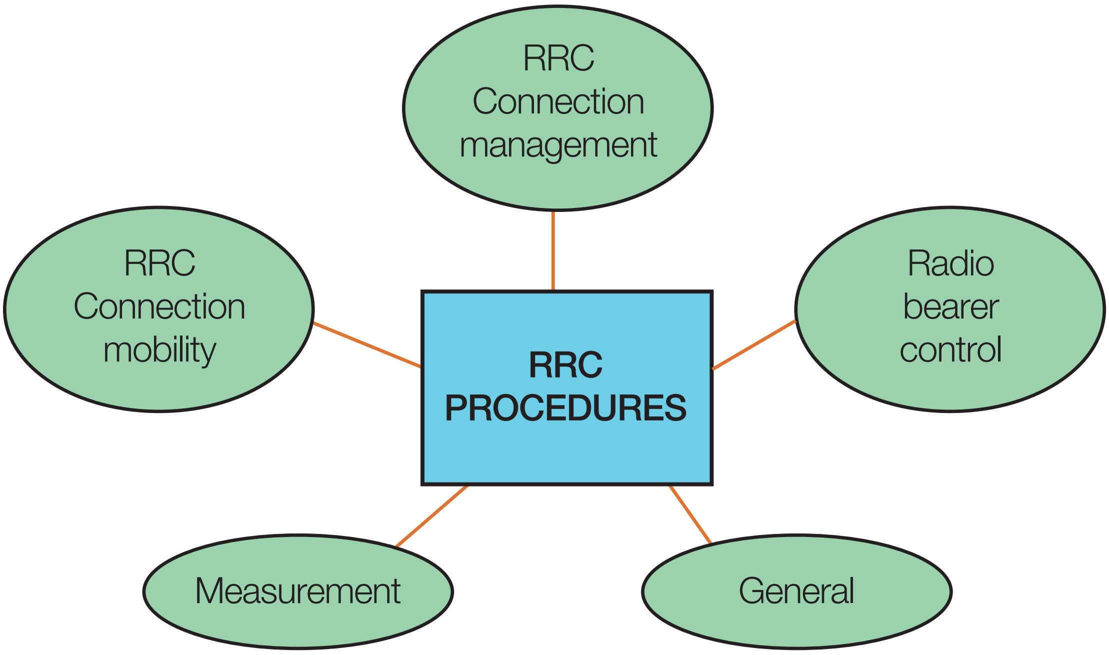
Overall RRC procedures can be classified under five general headings:

- Connection Management procedures.
- Radio Bearer Control Procedures.
- Connection Mobility Procedures.
- Measurement Procedures.
- General Procedures.

The RRC PDUs used for these procedures are summarised in the Appendix to this section.

5.1 RRC Connection Management

Main connection management procedures are listed in figure 7 and relate in general to the broadcast of System Information, RRC connection establishment, direct transfer (by encapsulation) of higher layer signalling and paging / notification. The following pages examine selected procedures in more detail.



RRC CONNECTION MANAGEMENT

- System Information (SI) broadcast
- RRC connection establishment
- RRC connection release
- RRC connection re-establishment
- Paging and Notification
- UE capability enquiry
- Transmission of UE capability information
- UE dedicated paging
- Initial direct transfer
- Uplink direct transfer
- Downlink direct transfer
- Security mode control
- Signalling connection release request
- Signalling connection release

Fig. 7 – RRC – Main Procedures

5.1.1 Broadcast of System Information

System Information in terms of static and dynamic parameters is organised into System Information Blocks (SIBs). To provide flexibility, information is disseminated amongst a “family tree” of 16 SIBs, each of which can be further subdivided. A specific SIB contains scheduling information for the main 16 blocks and they in turn contain information about scheduling of related sub-blocks.

SIBs are either segmented or concatenated as required into System Information messages lasting 20 ms (2 radio frames). Padding may be added to fill a message.

SI messages are scheduled over a repetition period (SIB_REP). The position of the first message is defined by SIB_POS (0) and the offset between subsequent segments by SIB_OFF (i).

The cell system frame number increments from 0 to 4094 in steps of 2 radio frames (20 ms) and is used to define these timings.

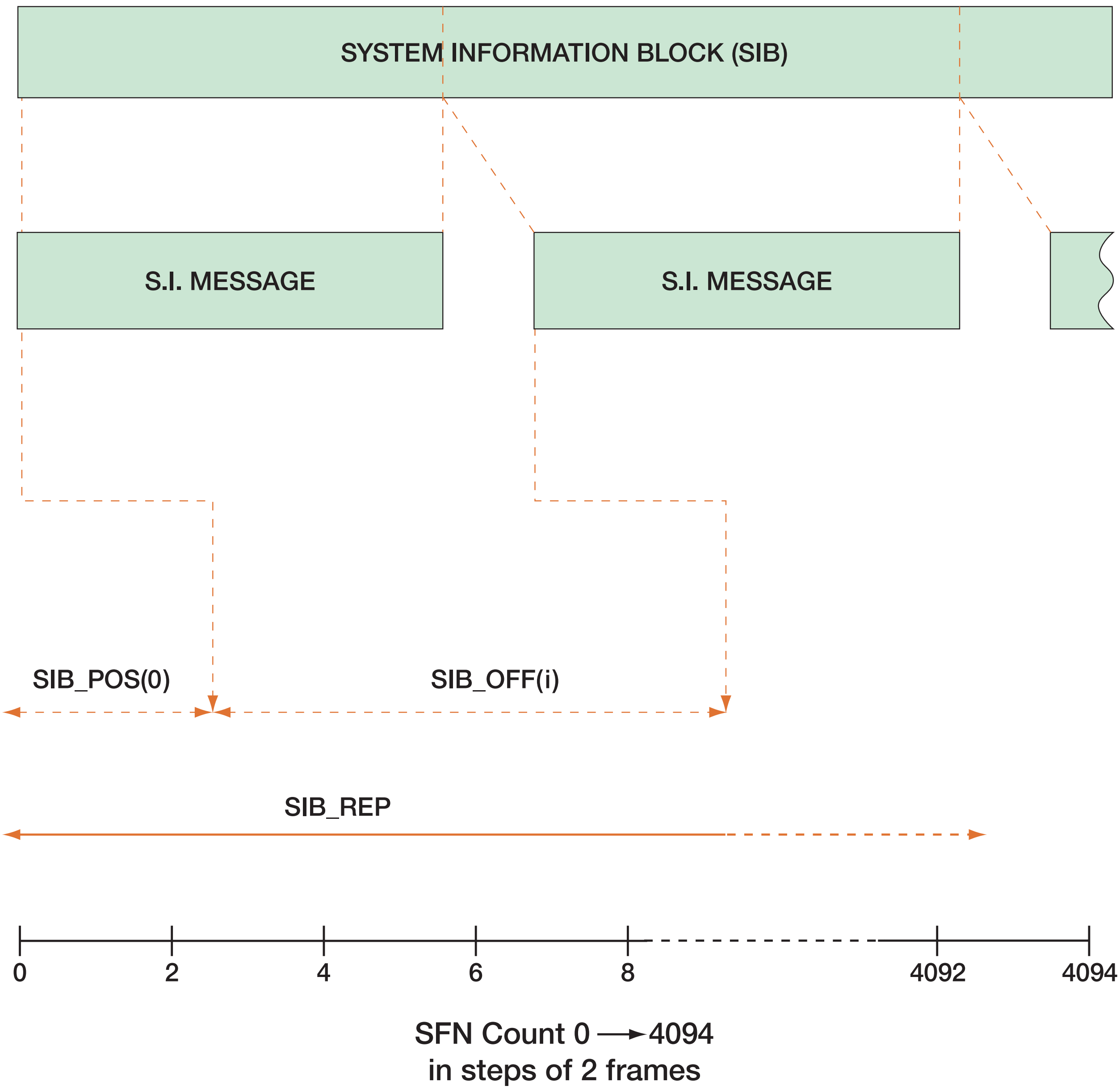


Fig. 8 – SIB Scheduling

5.1.2 RRC Connection Control

The UE must establish an RRC connection with the UTRAN before any connected mode procedures can take place.

In response to a paging indication, or autonomously, the UE initiates the procedure by transmitting an RRC Connection Request message on the PRACH. The UE identifies itself by IMSI, TMSI, P-TMSI or possibly IMEI. This identity is used by the UTRAN for contention resolution purposes.

The UTRAN will respond with an RRC Connection set-up message containing a description of the Radio Bearer assigned (code, frequency and possibly timeslot assignment, plus other parameters), plus a U-RNTI and optionally a C-RNTI. A UE making an unsuccessful access attempt will receive an RRC Connection Reject message which may contain an indication for the UE to attempt a retry.

The UE moves to the assigned channel and sends RRC Connection Complete, identifying itself by U-RNTI if using a DCH/DPCH or C-RNTI if using PRACH/RACH.

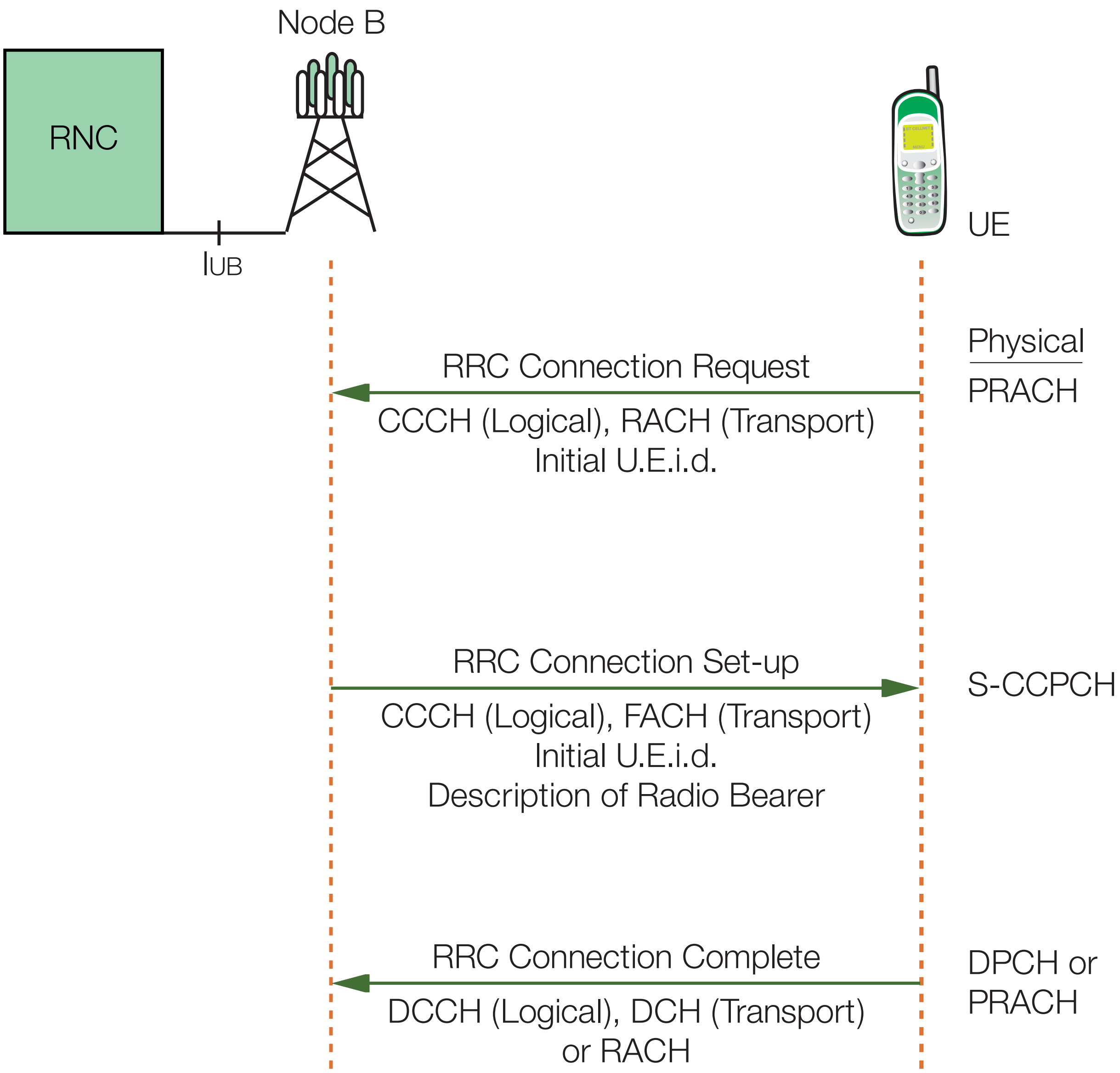


Fig. 9 – RRC Connection Control

5.1.3 Paging Activity and Causes

Paging by RRC may be related to three different causes.

Paging to set up a CS call or PS session originating in the Core Network, may be forwarded by RRC.

A UE with a PS connection and currently “sleeping” in CELL_PCH or URA_PCH state may be paged by the UTRAN to bring it into the CELL_FACH state upon resumption of a DL packet stream.

UEs may also be paged to advise of a change in System Information (SI) that they should read.

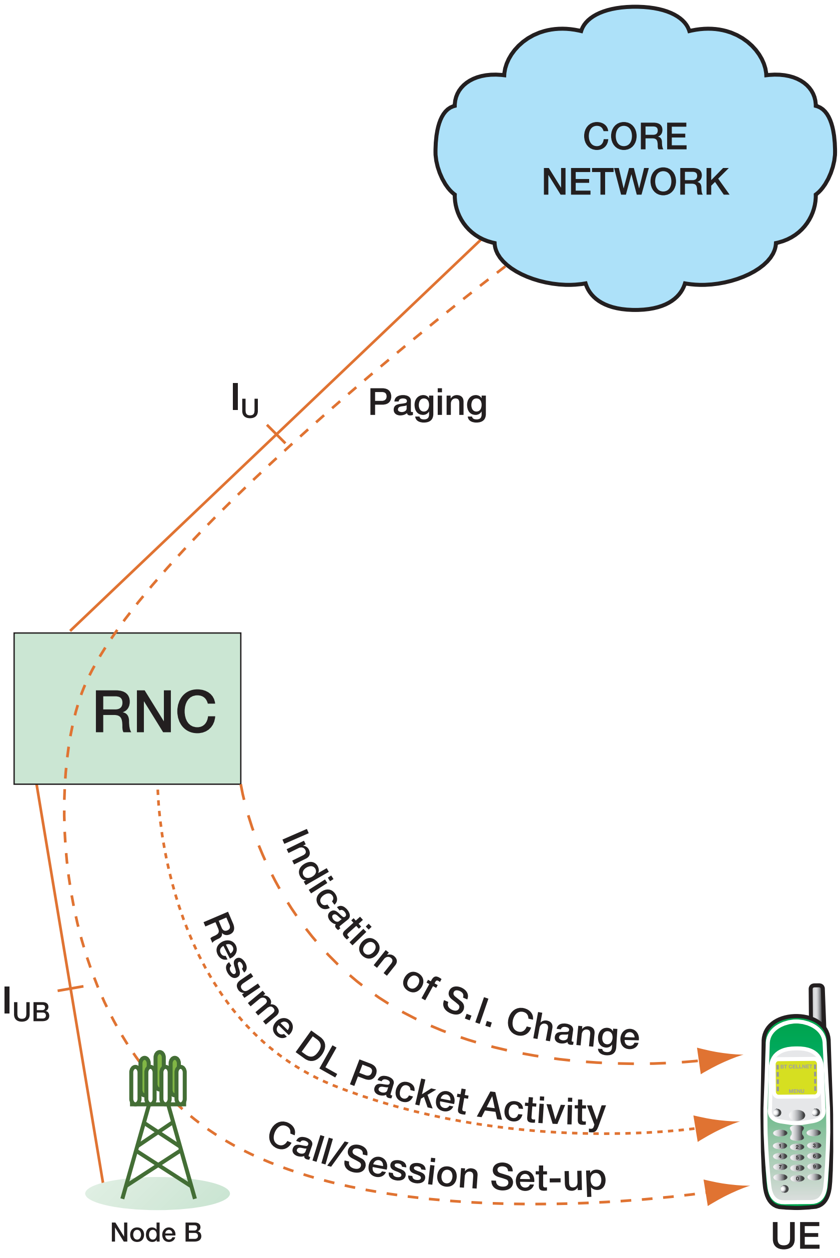


Fig. 10 – Paging Causes

5.1.4 RRC Direct Transfer

Direct transfer is used to provide transparent transfer (by encapsulation) of higher layer NAS signalling between UE and CN.

The Initial Direct Transfer message includes the Service Description and Core Network domain identity which are used by the UTRAN to ensure correct routing to the appropriate CN domain.

Further uplink and downlink direct transfer messages complete the signalling process.

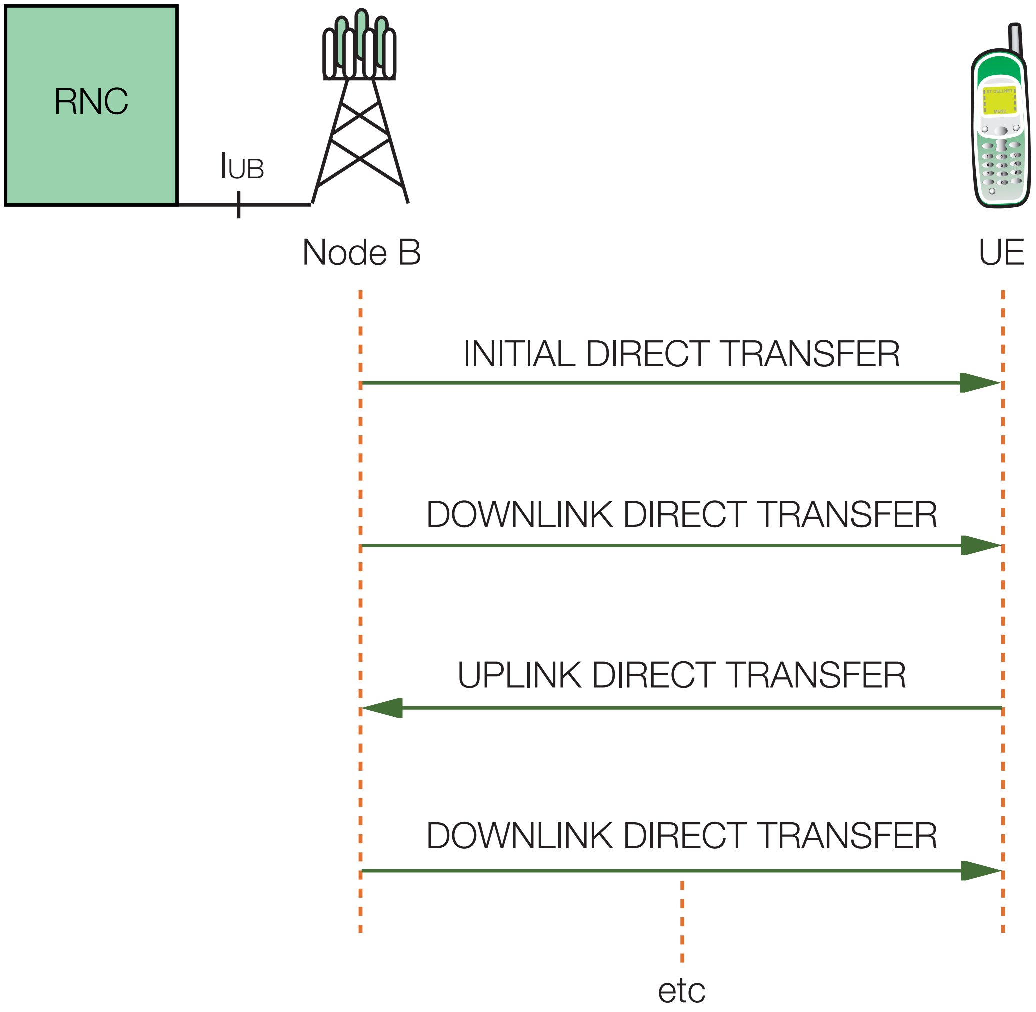


Fig. 11 – RRC Direct Transfer

5.1.5 Security Mode Control

Once a UE has established an RRC connection, RRC may initiate security mode control in the form of ciphering (encryption) and integrity protection.

Integrity protection works at RRC level to ensure the integrity of RRC messages exchanged. An integrity algorithm called f9 generates a 32 bit checksum for all RRC messages. To do so, f9 requires input parameters and some of these are included in the security mode command.

Ciphering or encryption on data can be carried out on both signalling and traffic between the UE and SRNC. Although ordered by RRC, it is implemented by RLC (or MAC, if RLC is working in TRM).

Once the UTRAN initiates ciphering, all radio bearers are suspended until the security mode complete message has been received from the UE. Similarly, radio bearers in the UE are suspended until the message is sent.

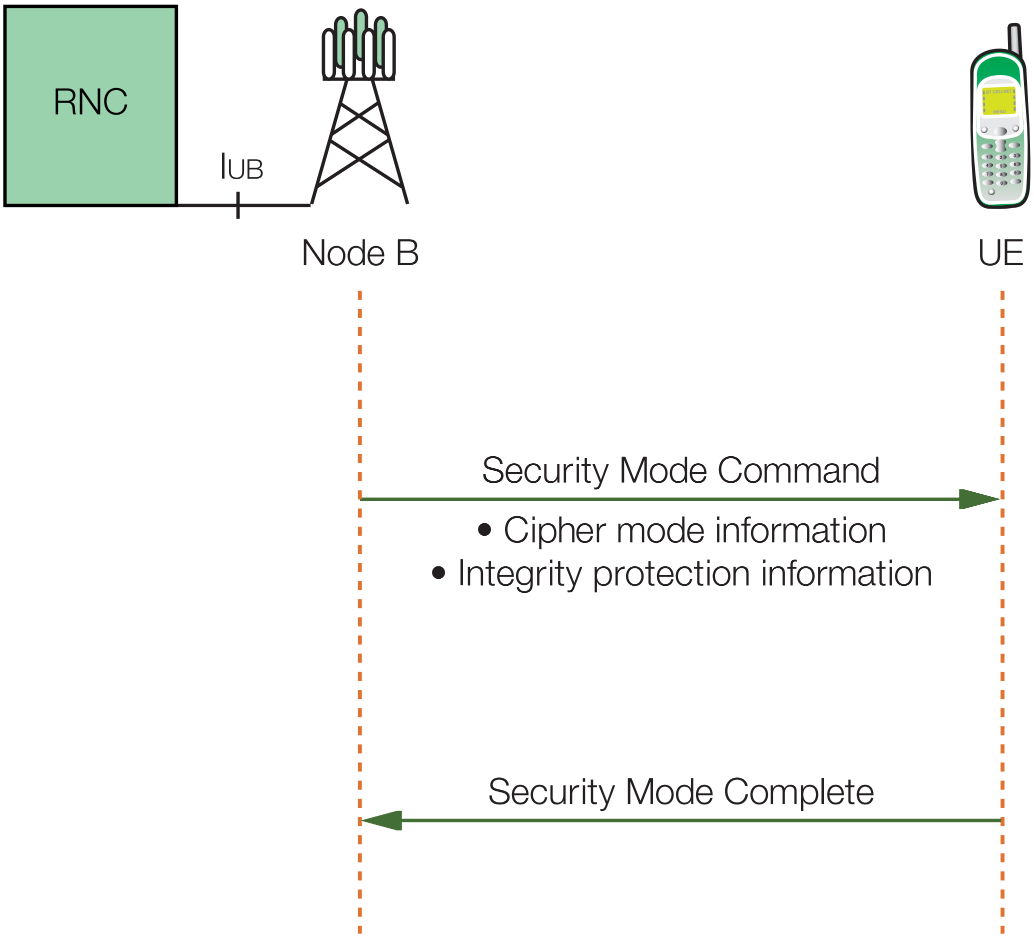


Fig. 12 – Security Mode Control

5.2 Radio Bearer Control

The main radio bearer control procedures are listed in figure 13. They relate mainly to the setup, reconfiguration and release of radio bearers, outer loop power control and traffic capacity (TDD mode only).

RADIO BEARER CONTROL

- Radio bearer setup
- Radio bearer re-configuration
- Radio bearer release
- Transport channel re-configuration
- Transport format combination control
- Physical channel re-configuration
- DL Outer loop power control
- UL Physical channel control
- Physical shared channel allocation (TDD)
- PUSCH capacity request (TDD)

Fig. 13 – Radio Bearer Control

5.2.1 Radio Access Bearers (RAB)

Radio Access Bearer (RAB) is the term used to describe the overall bearer service between the Core Network node (MSC or SGSN) and the UE (user plane).
The Radio Bearer, RLC, MAC and the LI channels form part of the RAB and it is the responsibility of RRC. At connection set up, RRC must provision an appropriate RAB to suit the required QoS. Lower layers in the UE and UTRAN are responsible for measuring traffic load and reporting to RRC to aid in the provision of appropriately configured RABs. The Transport Channels between MAC and LI may also need dynamic re-configuration during a connection for example from common (e.g. RACH) to dedicated (DCH) and RRC needs to determine the need for, and implement, such changes.

5.2.2 Signalling Radio Bearers (SRB)

Radio bearers to carry signalling are set up as part of the RRC connection establishment process. Several radio bearers, to carry both signalling and direct transfer data, are required. Correct configuration of the radio bearer includes appropriate RLC/MAC functionality to be set up by RRC. 32 radio bearers are available for signalling, as follows:

RB0 – for all CCCH messages (RLC UM and RLC TRM)

RB1 – for DCCH signalling using RLC UM

RB2 – for DCCH signalling using RLC AM (except those carrying NAS signalling)

RB3 – for DCCH signalling using RLC aM and carrying NAS signalling. (Optionally RB4 also)

RB5 ➔ RB31 – for DCCH signalling using RLC TRM.

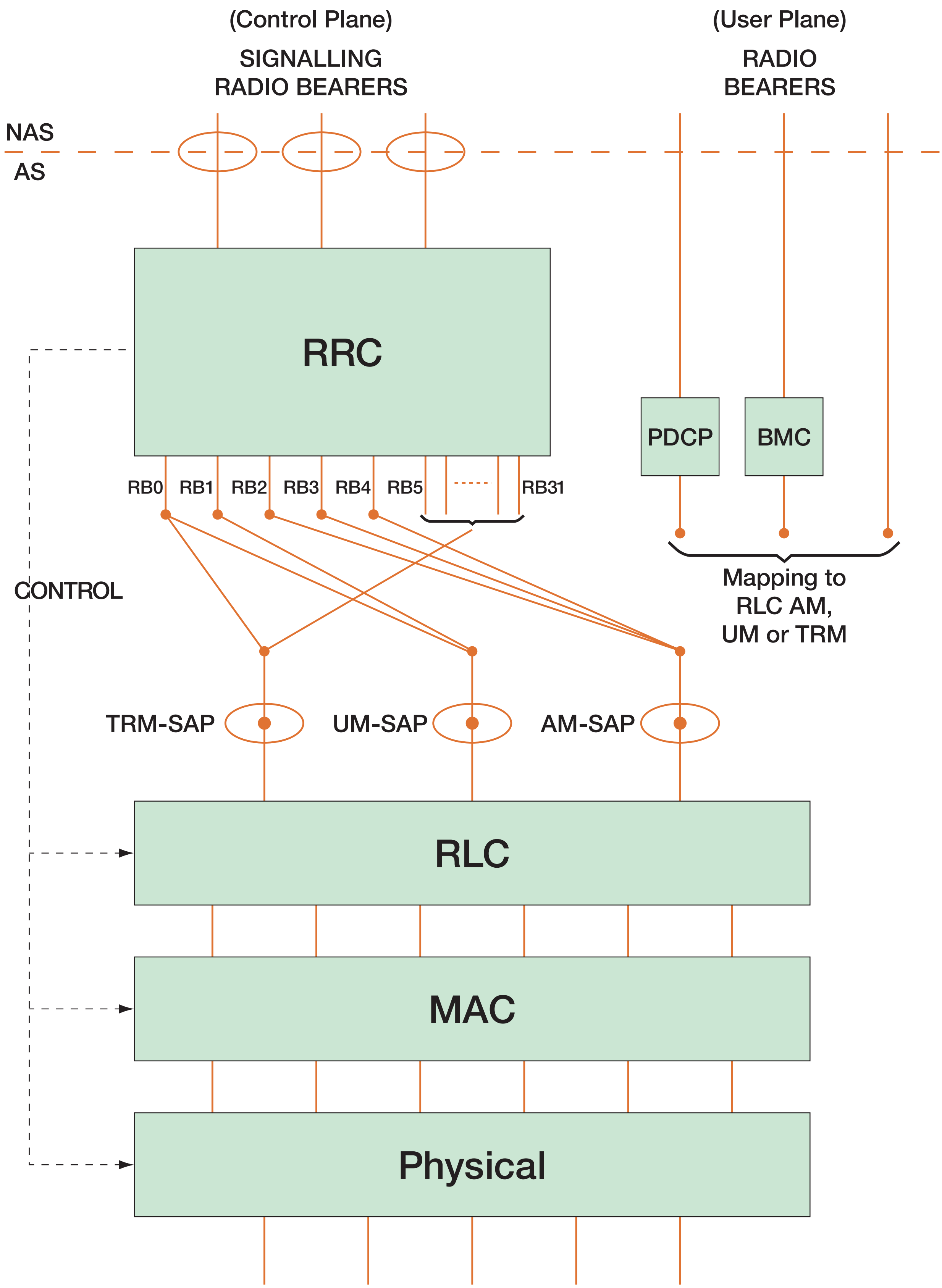


Fig. 14 – Radio Bearers

5.3 RRC Connection Mobility Procedures

The main RRC connection mobility procedures are summarised in figure 15.

They are concerned with cell and URA level updating, procedures concerning soft, hard and inter-system handover, inter-system cell re-selection and RNTI re-allocation.

RRC CONNECTION MOBILITY

- Cell update (basic, basic plus RNTI re-allocation, basic plus physical channel re-allocation)
- URA update (basic, basic plus RNTI re-allocation)
- Active set update (in soft handover)
- Hard handover within UTRAN
- Inter-system handover to/from UTRAN
- Inter-system cell reselection to/from UTRAN
- RNTI re-allocation

Fig. 15 – RRC Connection Mobility

5.3.1 Cell and URA Updating

UEs in PS connected mode are required to perform cell updating or URA updating with the UTRAN, depending on their RRC service state.

Cell updating must be performed by UEs in CELL_FACH or CELL_PCH states each time the UE selects a new cell (cell re-selection) or upon time expiry. Additionally, UEs in URA_PCH state must carry out a cell update either if pages (by the UTRAN) or if they wish to initiate packet data transfer. Cell updates can be basic, basic with RNTI re-allocation or basic with physical channel re-configuration URA updating must be performed by UEs in the URA_PCH state each time the mobile re-selects a new cell belonging to a URA which is not that currently assigned to the UE. Cells can belong to multiple URAs and if this is the case, the UE stores all valid URAs for the cell until assigned a specific URA by the UTRAN. URA updating can also be triggered upon timer expiry in the UE. Like cell updating, URA updating can be a basic procedure or basic plus RNTI re-allocation.

The procedures for cell and URA updates are very similar. Figure 16 illustrates the procedure for cell updating. A UE performing cell re-selection will send a cell update message, including a cause value and existing RNTI. The response from the UTRAN includes a new RNTI, which the UE acknowledges with the UTRAN Mobility Information confirm message.

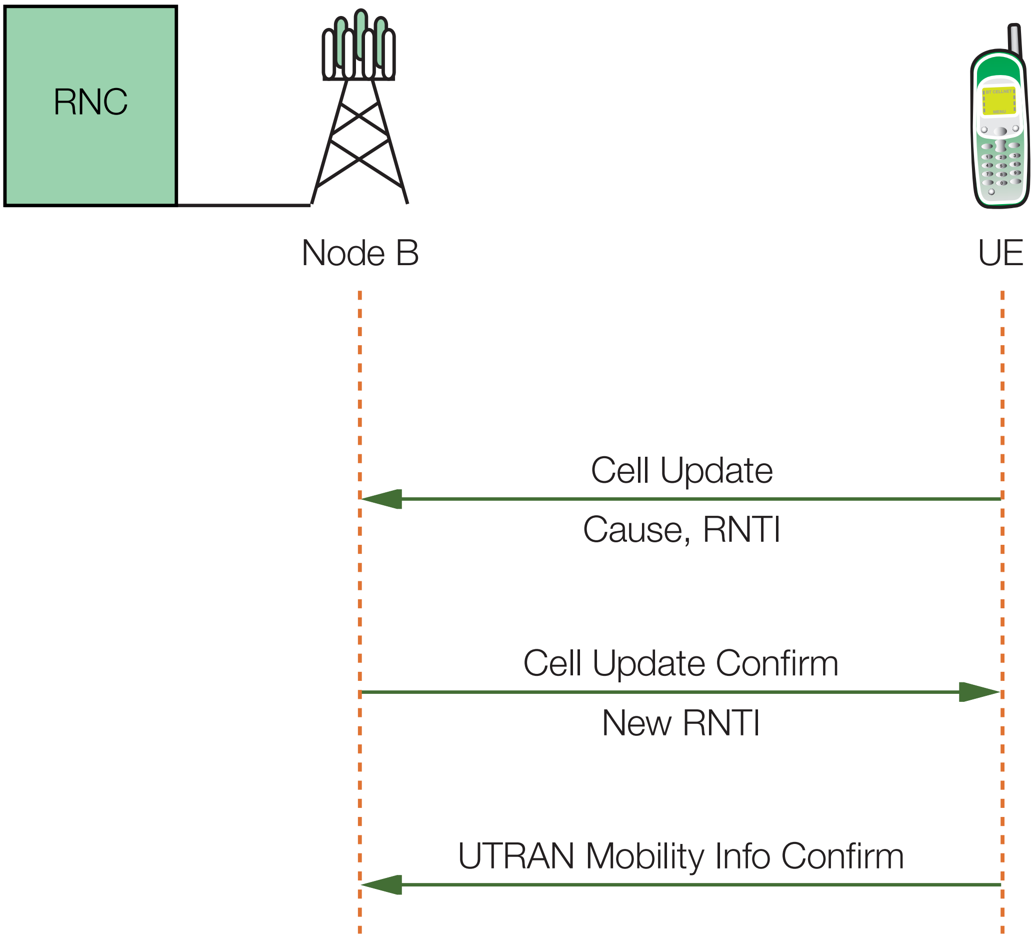


Fig. 16 – Cell update with RNTI Re-allocation

5.3.2 Handover and External Cell Reselection

RRC has overall responsibility for controlling handovers and external cell reselection procedures.

Handovers include soft (and softer) handovers within the UTRAN. These occur in FDD mode only between cells using the same radio frequency. Hard handovers within the UTRAN will occur between FDD cells using different radio frequencies, FDD ⇔ TDD cells and TDD ⇔ TDD cells. Hard handover outside the UTRAN (e.g. GSM ⇔ UMTS) involve both a change of RAT and frequency.

Figure 17 shows a soft or softer handover procedure. The UE will be in CELL_DCH state and reporting measurements of up to 32 neighbour cells to the UTRAN. Once defined conditions have been met, the UTRAN send an Active Set Update message to the U.E., containing details of a new radio link (RL) to be added to those currently in use (the Active Set). The defined conditions triggering the Active Set Update include QoS (e.g. BER/SIR), system load and UE location. The UE implements the update, adding the new RL to its active set and then sends the Active Set Update complete message back to the UTRAN.

- Soft Handover within the UTRAN
  (Node Bs using the same radio frequency)
- Hard Handover within the UTRAN
  (Node Bs using different radio frequencies)
- Hard Handover outside the UTRAN
  e.g. UMTS ↔ GSM. Radio frequency different
- Cell Reselection outside the UTRAN
  e.g. UMTS ↔ GSM. Radio frequency different

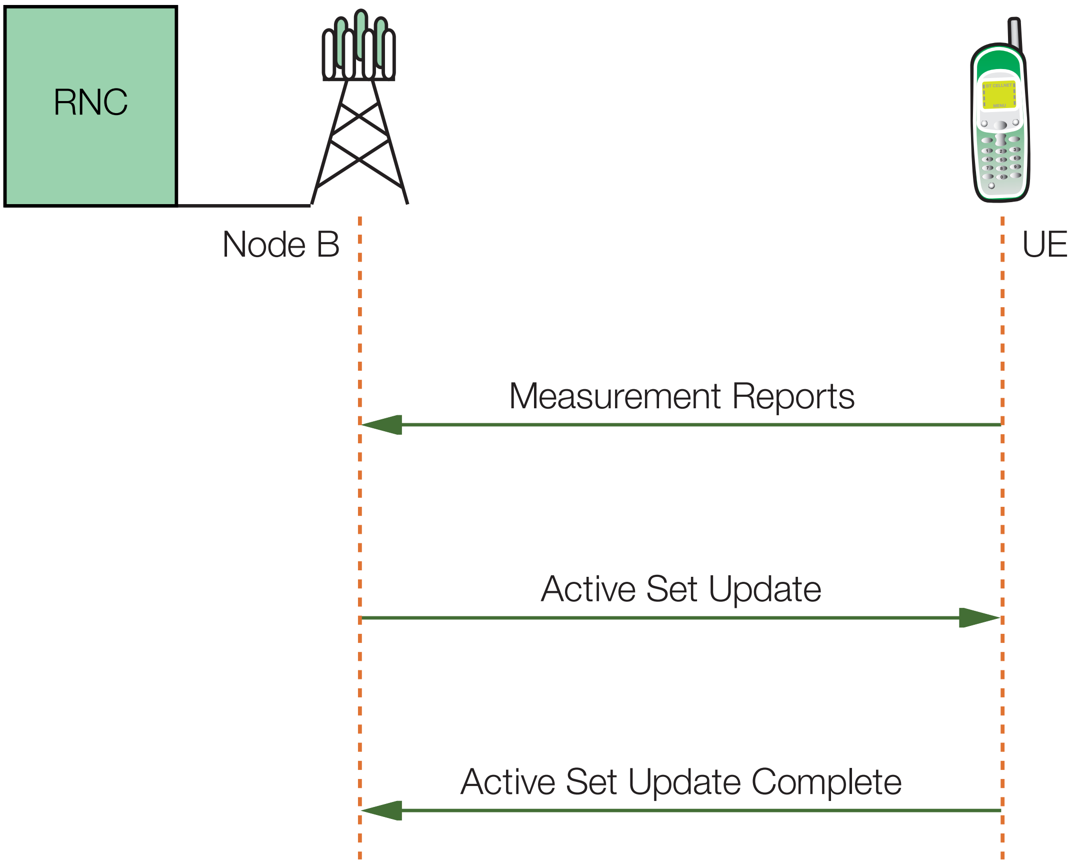


Fig. 17 – RRC Mobility and Soft Handover

5.4 Measurement Procedures

Measurement by both the UTRAN and the UE are vital for power control, handover and LCS processes. The UE is required to provide Measurement Reports, the contents of which are defined by the UTRAN through RRC Measurement Control procedures.

5.4.1 Measurement Control

UEs in any RRC state may be sent a Measurement Control message to set-up, modify or terminate measurements. Various parameters define the action required.

The Measurement Command parameter indicates whether a set-up, modification or termination is required and the Measurement Type defines the type of quantity to be measured. A Measurement Identity Number identifies the measurement for future reference (e.g. termination). Neighbour cell information is indicated by the Measurement Objects parameter. Specific details of the quantities to be measured are provided by the Measurement Quantity parameter, but the UE will only report those quantities indicated by the Reporting Quantities parameter. Measurement Reporting Criteria determine the conditions triggering a report and finally, Reporting Mode indicates whether RLC AM or UM should be used.

The RRC Measurement Control message is used only for UEs in the DELL_DCH State. In any other state, instructions about measurements to be made are sent on the P-CCPH through SI messages.

5.4.2 Measurement Reporting

UEs in the CELL_DCH state supply information using the Measurement Report message or may be instructed to attach the measurements to other RRC messages.

MEASUREMENT CONTROL MESSAGE

- Measurement Command
- Measurement Type
- Measurement Identity Number
- Measurement Objects
- Measurement Quantity
- Reporting Quantities
- Reporting Mode
- Measurement Reporting Criteria

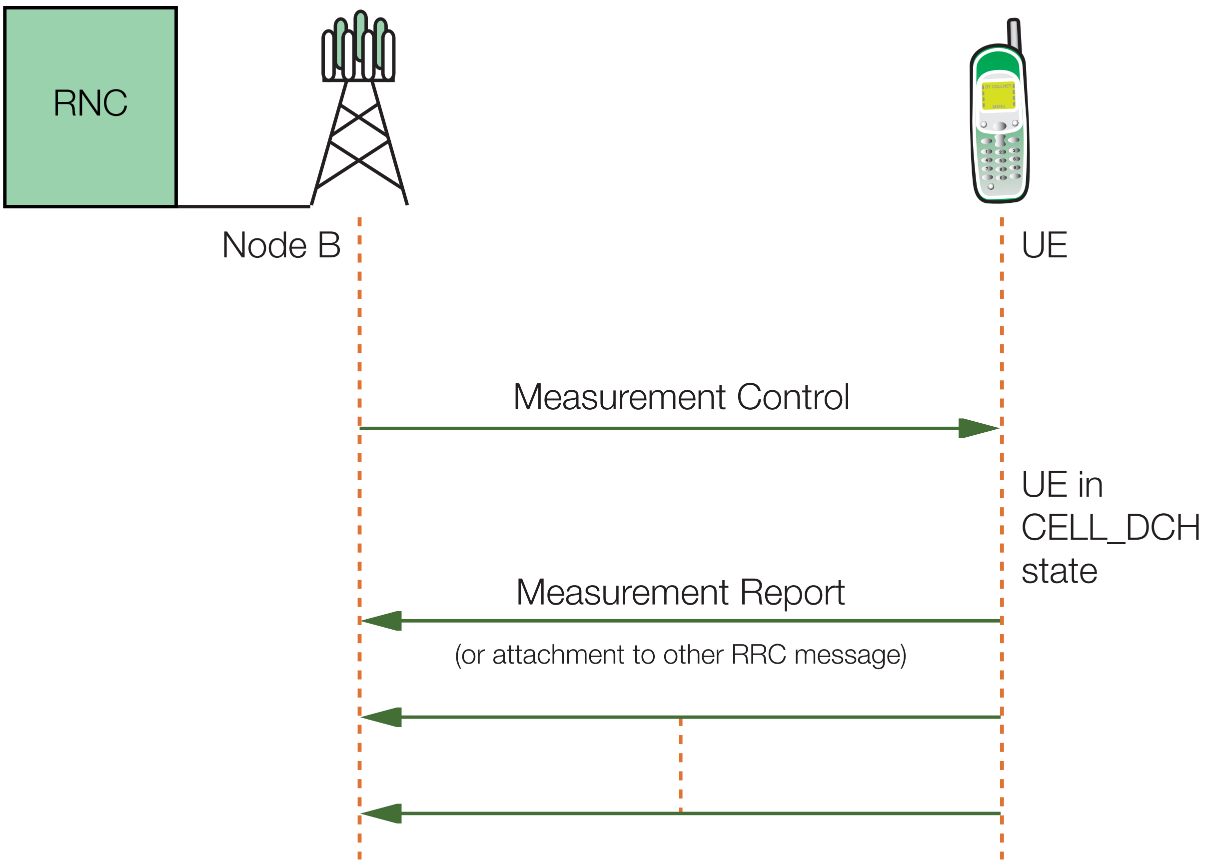


Fig. 18 – RRC Measurement Control

5.4.3 Measurement Types

Figure 19 summarises main measurement types that may be indicated to the UE by the UTRAN. These include intra-frequency serving and neighbour cell measurements, inter-frequency measurements, inter-system measurements (such as GSM), uplink traffic volume measurements, downlink quality measurements, measurement for LCS and also internal UE measurements.

MEASUREMENT TYPES

- Intra frequency
- Inter frequency
- Inter system
- Downlink quality
- Uplink traffic volume
- LCS related
- Internal (UE)

Fig. 19 – UE Measurement Types

5.5 General RRC Procedures

Main procedures are listed in figure 20.

RRC deals with open loop power control by calculating appropriate initial power levels for PRACH, PCPCH or DPCCH use. Access service classes are used to manage and prioritise PRACH usage between UEs, and involves mapping the UE Access Class to an Access Service Class.

To manage orderly physical channel establishment, RRC uses a timer (T312) to determine successful establishment. Radio link failure is detected (for UEs in CELL_DCH state) using two counters (N313 and N315) and the timer T313.

Integrity protection is carried out for the majority of RRC messages, using a checksum.

RRC must also detect when it is out of its registered cell or URA and take appropriate action, using counters and timers together with RRC mobility management procedures.

When the UE is entering idle mode from connected mode, RRC manages the overall selection of most appropriate PLMN and cell.

If a UE is about to commence RRC connection procedures, RRC must also select an appropriate initial identity to use in the procedure. This could be IMSI, P-TMSI, TMSI or IMEI.

UEs in the CELL_FACH state are required under some circumstances to make measurements with a frequency determined by calculation by RRC.

GENERAL RRC PROCEDURES

- Open-loop power control
- Access service class management
- Access class management
- Physical channel establishment
- Radio link failure
- Integrity protection
- Out-of-service area detection
- Connected ⟶ idle mode transitions
- Selection of initial UE identity
- Measurement timing

Fig. 20 – Main General RRC Procedures

APPENDIX
RRC PDU Types

NAME	LOGICAL CHANNEL	DIRECTION	SAP RLC-AM, UM	FDD/TDD (FT, F, T)
ACTIVE SET UPDATE	DCCH	DL	RLC-AM	F
ACTIVE SET UPDATE COMPLETE	DCCH	UL	RLC-AM	F
ACTIVE SET UPDATE FAILURE	DCCH	UK	RLC-AM	F
CELL UPDATE	CCCH	UL	RLC-TM	FT
CELL UPDATE CONFIRM	DCCH	DL	RLC-UM	FT
DOWNLINK DIRECT TRANSFER	DCCH	DL	RLC-AM	FT
DOWNLINK OUTER LOOP CONTROL	DCCH	DL	RLC-AM,UM	FT
HANDOVER TO UTRAN COMMAND	–	DL	–	FT
HANDOVER TO UTRAN COMPLETE	DCCH	UL	RLC-AM	FT
INITIAL DIRECT TRANSFER	DCCH	UL	RLC-AM	FT
INTER-SYSTEM HANDOVER COMMAND	DCCH	DL	RLC-AM	FT
INTER-SYSTEM HANDOVER FAILURE	DCCH	UL	RLC-AM	FT
MEASUREMENT CONTROL	DCCH	DL	RLC-AM	FT
MEASUREMENT CONTROL FAILURE	DCCH	UL	RLC-AM	FT
MEASUREMENT REPORT	DCCH	UL	RLC-AM	FT
PAGING TYPE 1	PCCH	DL	RLC-TM	FT
PAGING TYPE 2	DCCH	DL	RLC-AM	FT
PHYSICAL CHANNEL RECONFIGURATION	DCCH	DL	RLC-AM,UM	FT
PHYSICAL CHANNEL RECONFIGURATION COMPLETE	DCCH	UL	RLC-AM	FT
PHYSICAL CHANNEL RECONFIGURATION FAILURE	DCCH	UL	RLC-AM	FT
PHYSICAL SHARED CHANNEL ALLOCATION	SHCCH	DL	RLC-TIM,UM	T
PUSCH CAPACITY REQUEST	SHCCH	UL	RLC-TM	T
RADIO BEARER RECONFIGURATION	DCCH	DL	RLC-AM,UM	FT
RADIO BEARER RECONFIGURATION COMPLETE	DCCH	UL	RLC-AM	FT
RADIO BEARER RECONFIGURATION FAILURE	DCCH	UL	RLC-AM	FT
RADIO BEARER RELEASE	DCCH	DL	RLC-AM,UM	FT
RADIO BEARER RELEASE COMPLETE	DCCH	UL	RLC-AM	FT
RADIO BEARER RELEASE FAILURE	DCCH	UL	RLC-AM	FT
RADIO BEARER SET UP	DCCH	DL	RLC-AM,UM	FT
RADIO BEARER SET UP COMPLETE	DCCH	UL	RLC-AM	FT
RADIO BEARER SET UP FAILURE	DCCH	UL	RLC-AM	FT
ANTI RE-ALLOCATION	DCCH	DL	RLC-AM,UM	FT
ANTI RE-ALLOCATION COMPLETE	DCCH	UL	RLC-AM	FT
ANTI RE-ALLOCATION FAILURE	DCCH	UL	RLC-AM	FT
RRC CONNECTION RE-ESTABLISHMENT	CCCH,DCCH	DL	RLC-UM	FT
RRC CONNECTION RE-ESTABLISHMENT COMPLETE	DCCH	UL	RLC-AM	FT
RRC CONNECTION RE-ESTABLISHMENT REQUEST	CCCH	UL	RLC-TM	FT
RRC CONNECTION REJECT	CCCH	DL	RLC-UM	FT
RRC CONNECTION RELEASE	DCCH	DL	RLC-UM	FT
RRC CONNECTION RELEASE COMPLETE	DCCH	UL	RLC-AM,UM	FT
RRC CONNECTION REQUEST	CCCH	UL	RLC-TM	FT
RRC CONNECTION SET UP	CCCH	DL	RLC-UM	FT
RRC CONNECTION SET UP COMPLETE	DCCH	UL	RLC-AM	FT
RRC STATUS	DCCH	UL	RLC-AM	FT
SECURITY MODE COMMAND	DCCH	DL	RLC-AM	FT
SECURITY MODE COMPLETE	DCCH	UL	RLC-AM	FT
SECURITY MODE FAILURE	DCCH	UL	RLC-AM	FT
SIGNALLING CONNECTION RELEASE	DCCH	DL	RLC-AM	FT
SYSTEM INFORMATION	BCH	DL	RLC-UM	FT

Fig. A1 – RRC PDU Types