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TECHNICAL SPECIFICATION

**Satellite Earth Stations and Systems (SES);
Family SL Satellite Radio Interface (Release 1);
Part 3: Control Plane and User Plane Specifications;
Sub-part 2: Bearer Control Layer Operation**

Reference

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Contents

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The present document is part 3, sub-part 2 of a multi-part deliverable. Full details of the entire series can be found in ETSI TS 102 744-1-1 [i.1].

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

This multi-part deliverable (Release 1) defines a satellite radio interface that provides UMTS services to users of mobile terminals via geostationary (GEO) satellites in the frequency range 1 518,000 MHz to 1 559,000 MHz (downlink) and 1 626,500 MHz to 1 660,500 MHz and 1 668,000 MHz to 1 675,000 MHz (uplink).

1 Scope

The present document defines the Bearer Control Layer (BCt) operation of the Family SL satellite radio interface between the Radio Network Controller (RNC) and the User Equipment (UE) used in the satellite network. The Bearer Control Layer (BCt) peer-to-peer interface is described in ETSI TS 102 744-3-1 [8].

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 133 102: "Universal Mobile Telecommunications System (UMTS); 3G security; Security architecture (3GPP TS 33.102 Release 4)".

[2] ETSI TS 133 105: "Universal Mobile Telecommunications System (UMTS); Cryptographic algorithm requirements (3GPP TS 33.105 Release 4)".

[3] ETSI TS 135 201: "Universal Mobile Telecommunications System (UMTS); Specification of the 3GPP confidentiality and integrity algorithms; Document 1: f8 and f9 specifications (3GPP TS 35.201 Release 4)".

[4] ETSI TS 102 744-1-3: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 1: General Specifications; Sub-part 3: Satellite Radio Interface Overview".

[5] ETSI TS 102 744-1-4: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 1: General Specifications; Sub-part 4: Applicable External Specifications, Symbols and Abbreviations".

[6] ETSI TS 102 744-2-1: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 2: Physical Layer Specifications; Sub-part 1: Physical Layer Interface".

[7] ETSI TS 102 744-2-2: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 2: Physical Layer Specifications; Sub-part 2: Radio Transmission and Reception".

[8] ETSI TS 102 744-3-1: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 1: Bearer Control Layer Interface".

[9] ETSI TS 102 744-3-4: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Inter Part 3: Control Plane and User Plane Specifications; Sub-part 4: Bearer Connection Layer Operation".

[10] ETSI TS 102 744-3-9: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 9: Initiation and Operation of User Plane".

[11] ETSI TS 102 744-3-3: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 3: Bearer Connection Layer Interface".

[12] ETSI TS 102 744-3-5: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 5: Adaptation Layer Interface".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 102 744-1-1: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 1: General Specifications; Sub-part 1: Services and Architectures".

3 Symbols and abbreviations

3.1 Symbols

For the purposes of the present document, the symbols given in ETSI TS 102 744-1-4 [5], clause 3 apply.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI TS 102 744-1-4 [5], clause 3 apply.

4 General Architecture

The Bearer Control Layer (BCt) provides medium access control functionality for both the control and user planes. Figure 4.1 illustrates the position of the Bearer Control Layer within the Family SL air interface protocol stack. An overview of the radio interface layering and relationship to the Bearer Control Layer is provided in ETSI TS 102 744-1-3 [4], clause 4 and ETSI TS 102 744-3-1 [8], clause 4. An overview of the Bearer Control Layer operation is provided in ETSI TS 102 744-1-3 [4], clause 7.

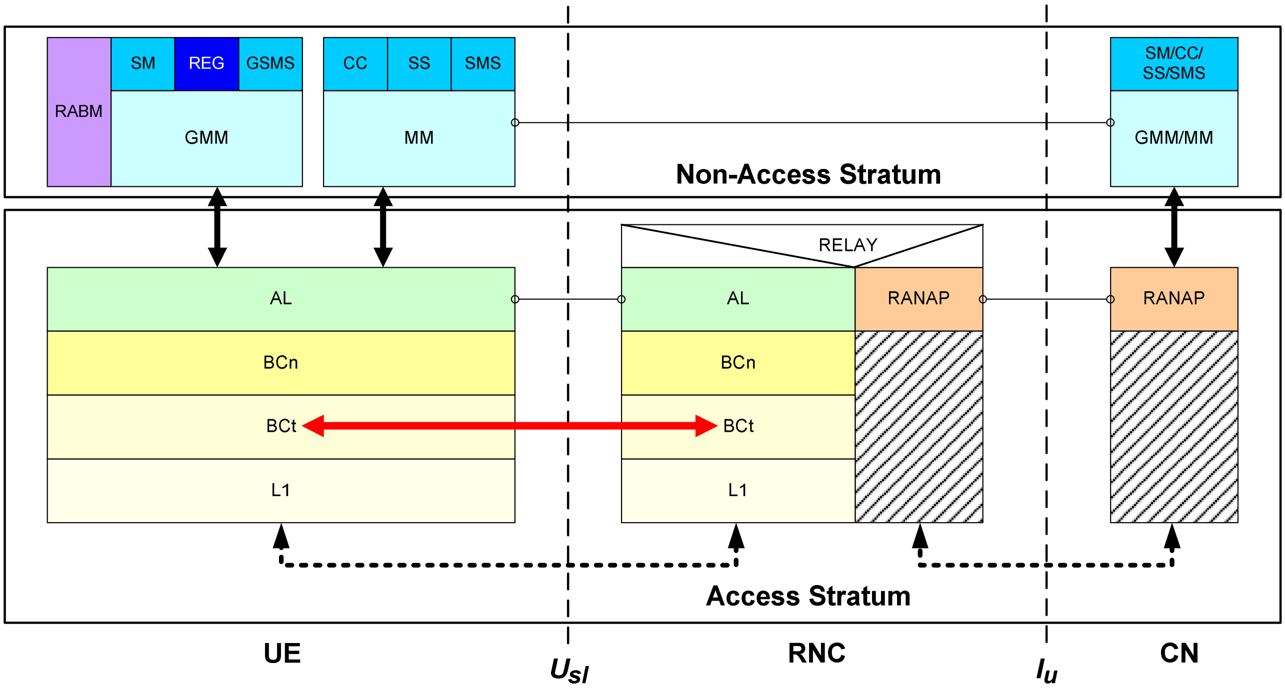

Figure 4.1: Bearer Control Layer Position in Protocol Stack (Control Plane Illustrated)

The Bearer Control Layer is responsible for the management and set-up of physical bearers. Its operations include:

- Transfer of data over one or more forward and return physical bearers (each RNC supports multiple forward and return physical bearers)
- Transfer of data to and from UEs where each UE may have multiple simultaneous data connections each with its own QoS requirements
- Dynamic switching of UE between different forward and return bearers
- Handover of connections to/from other Bearer Control entities for mobility management purposes without the need to close and restart connections
- Reconfiguration of connection QoS during the life-time of a connection (supported by Bearer Control layer on QoS command from Adaptation Layer)
- Perform timing measurement and adjustment
- Perform link adaptation to optimize data rate of the system
- Perform Sleep Mode operation to allow UE to conserve power
- Perform resource management control, including admission control, time slot allocation, etc., to ensure the QoS of each UEconnection is met

The functions of the Bearer Control Layer are provided to the upper layers via a number of different service access points (SAPs).

The Bearer Control Layer consists of a number of Bearer Control Processes, each controlling a number of associated forward and return bearers. Typically one RNC Bearer Control Process will control all the channels used in one spot beam. However, more than one control process per beam is allowed. Each of these Bearer Control Processes is identified by a BCt-ID, which is transmitted in the forward link Bulletin Board Signalling Data Unit (SDU).

5 Bearer Control Services

5.1 Bearer Control Service Access Points

5.1.0 General

The internal architecture of the Bearer Control Process for the UE side is shown in simplified form in Figure 5.1. The diagram shows both control plane and user plane. The functionality is broadly categorized into control functions provided by the BCt Manager (BCtM) entity and data transfer functions provided by the UE BCt entity. A more detailed description of the internal architectural entities is provided in clause 3.

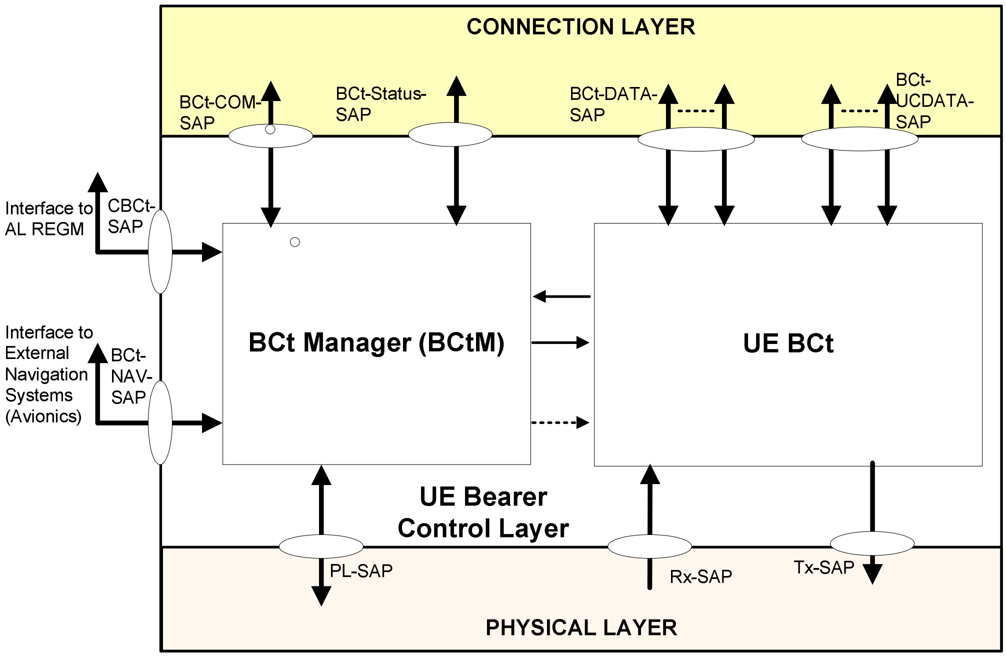

Figure 5.1: Bearer Control Layer Service Access Points (UE Side)

5.1.1 Services provided to Upper Layers

The Bearer Control Layer provides media access functions to the upper layers (Bearer Connection Layer and Adaptation Layer) via the following service access points (SAP).

- CBCt-SAP: providing services to AL related to initiation of PSAB discovery procedures, providing GPS position for reporting purposes and delivery of System Information.
- BCt-COM-SAP: providing services to AL related to common signalling procedures.
- STATUS-SAP: providing services to Bearer Connection Layer entities for control of the user-plane operation.
- BCt-DATA-SAP: providing data transport services to Bearer Connection Layer (BCn) for acknowledged and unacknowledged mode connections.
- BCt-UCDATA-SAP: providing data transport services to Bearer Connection Layer (BCn) for transparent mode connections.

5.1.2 Services Expected from the Lower Layers

The Bearer Control Layer relies on the Physical Layer for transmitting and receiving Bearer Control Protocol Data Units (PDUs) to its peer entity at the RNC side.

Three Service Access Points, namely the Physical Layer SAP (PL-SAP), Receive SAP (Rx-SAP) and Transmit SAP (Tx-SAP) are referenced in the present document. The detailed definition of primitives for these SAPs is implementation specific and therefore not specified further in the present document.

5.1.3 Services Expected from External Entities

The BCt-NAV-SAP interface is used to obtain geographical location and other navigational information from an external navigational sub-system. This external sub-system may be internal to the mobile terminal (typically the case for portable, maritime and land-vehicular mobile terminals), or may be provided by an external navigational sub-system (typically the case for aeronautical mobile terminals).

5.2 Bearer Control Layer Service Primitives

5.2.1 Data Transfer Service Access Points

5.2.1.1 BCt-DATA-SAP Primitives and Parameters

The BCt-DATA-SAP is used for the transfer of the Acknowledged Mode and Numbered Mode data between Bearer Connection and Control layer. The BCt-DATA-SAP primitives are shown in Table 5.1.

Table 5.1: BCt-DATA-SAP Primitives

Primitive	Direction	Parameters
BCt_TxDATA_REQ	To BCt	BCnID, DataSize, BCnPDU
BCt_TxDATA_IND	To BCn	DataSize, FinalSegRetxAllowedFlag
BCt_RxDATA_IND	To BCn	BCnID, DataSize, BCnPDU

The BCt_TxDATA_IND primitive is used to indicate to the Connection layer the capacity available for a specific connection in the current frame. The data handler (AM_DH or NUM_DH) in the connection layer will respond by sending the address (BCnID) and data (BCnPDU) to be sent using the BCt_TxDATA_REQ signal. On the receive side, received BCnPDUs are delivered to the Connection Layer using the BCt_RxDATA_IND primitive. The FinalSegRetxAllowedFlag is used to signal to the connection layer entity that it may use this payload to carry a retransmitted final data segment rather than a poll frame if the final data segment is sufficient to be accommodated within the offered DataSize. The FinalSegRetxAllowedFlag shall be set to TRUE if the return bearer is using either Controlled Random Access Mode or Shared Reservation Access Mode.

5.2.1.2 BCt-UCDATA-SAP Primitives and Parameters

The BCt-UCDATA-SAP is used for the transfer of the Transparent Mode data between Bearer Connection and Control layer. The BCt-UCDATA-SAP primitives are shown in Table 5.2.

Table 5.2: BCt-UCDATA-SAP Primitives

Primitive	Direction	Parameters
BCt_TxUCDATA_REQ	To BCt	BCnID, DataSize, BCnPDU
BCt_TxUCDATA_IND	To BCn	DataSize
BCt_RxUCDATA_IND	To BCn	BCnID, DataSize, BCnPDU, [errflg]

The BCt_TxUCDATA_IND primitive is used to indicate the capacity available for a specific connection in the current frame to the Connection layer. The data handler (TM_DH or UN_DH) in the connection layer will respond by sending the address (BCnID) and data (BCnPDU) to be sent using the BCt_TxUCDATA_REQ signal. On the receive side, received BCnPDUs are delivered to the Connection Layer using the BCt_RxUCDATA_IND primitive. If delivery of erroneous PDUs is requested, then any PDU with a failed CRC shall be marked with the error flag errflg.

5.2.2 Navigational Interface Service Access Points

5.2.2.1 BCt-NAV-SAP (Maritime and Land-Mobile Class UE Only)

The BCt-Nav-SAP is used by the BCtM to obtain geographical location and other navigational information from a navigational subsystem external to the Bearer Control layer. The BCt-Nav-SAP primitives for Portable, Maritime and Land Mobile UE are shown in Table 5.3.

Table 5.3: BCt-Nav-SAP Primitives (Portable, Maritime and Land Mobile UE)

Primitive	Direction	Parameters
CBCt_POS_REQ	From BCt	
CBCt_POS_CNF	To BCt	3D GPS Position (x,y,z or Lat,Long, Altitude)
CBCt_POS_IND	To BCt	3D GPS Position (x,y,z or Lat,Long, Altitude)
CBCt_VELOCITY_REQ (Optional)	From BCt	
CBCt_VELOCITY_CNF (Optional)	To BCt	Velocity vector of UE (v_x, v_y, v_z or compass direction, speed)
CBCt_VELOCITY_IND (Optional)	To BCt	Velocity vector of UE (v_x, v_y, v_z or compass direction, speed)
CBCt_ORIENTATION_REQ	From BCt	
CBCt_ORIENTATION_CNF	To BCt	UE orientation pitch, tilt, roll
CBCt_POINTING_IND	From BCt	Direction of boresight antenna gain relative to UE

The purpose of the interface is to ensure that the position information maintained by the Bearer Control information is accurate to 1 500 metres for the purpose of maintaining adequate return channel transmit timing.

The information may be either presented periodically by the external navigational subsystem using the CBCt_POS_IND primitive; or the external navigation subsystem may be polled by the BCtM entity using CBCt_POS_REQ primitive, to request an up-to-date position which will be provided within the CBCt_POS_CNF primitive.

The parameters contained in the CBCt_POS_IND primitive and the CBCt_POS_CNF primitive shall be used by BCtM for the dual purposes of:

1) Adjusting the return channel transmit timing mechanisms

2) Reporting location to the Adaptation Layer via the CBCt_SAP

If supported, the parameters contained in the CBCt_VELOCITY_CNF primitive may also be forwarded to the Adaptation Layer via the CBCt_POSITION_CNF on the CBCt_SAP to improve the timeliness of UE-initiated spot-beam selection and handover mechanisms.

The CBCt_ORIENTATION_REQ/ CONF primitives support the provision of attitude information to the BCt and are mainly applicable to mobile terminals, and are used to assist with rapid pointing of directional antenna subystems.

5.2.2.2 BCt_NAV_SAP Interface with avionics (Aeronautical Class UE Only)

The aeronautical UE shall be able to access regular updates of position and velocity from the avionics in order to be able to perform spot-beam selection and compensation for Doppler frequency offset, but the specifics of the interface are implementation-dependent.

For aeronautical UE, the BCt-Nav-SAP is used by the BCtM to exchange navigational and control information with an external navigational subsystem. For aeronautical subsystems, the interface towards the external navigational subsystem is typically supported via an ARINC-429 interface. The BCt-Nav-SAP primitives for Aeronautical UE are shown in Table 5.4.

Table 5.4: BCt-NAV-SAP Primitives (Aeronautical UE)

Primitive	Direction	Parameters
CBCt_POS_REQ	From BCt	
CBCt_POS_IND {Optional}	To BCt	3D GPS Position (x,y,z or Lat,Long, Altitude)
CBCt_POS_CNF	To BCt	3D GPS Position (x,y,z or Lat,Long, Altitude)
CBCt_VELOCITY_REQ	From BCt	
CBCt_VELOCITY_IND {Optional}	To BCt	Velocity vector of UE (v_x, v_y, v_z or compass direction, speed)
CBCt_VELOCITY_CNF	To BCt	Velocity vector of UE (v_x, v_y, v_z or compass direction, speed)
CBCt_WAYPOINT_REQ {Optional}	From BCt	
CBCt_WAYPOINT_IND {Optional}	To BCt	Sequence of {Position of aeroplane waypoint course marker}
CBCt_WAYPOINT_CNF {Optional}	To BCt	Sequence of {Position of aeroplane waypoint course marker}
CBCt_POINTING_IND	From BCt	Direction of boresight antenna gain in azimuth-elevation format
CBCt_BEAM_GAIN_REQ	From BCt	
CBCt_BEAM_GAIN_CNF	To BCt	EIRP (dBW) of the currently selected beam gain
CBCt_EIRP_IND	From BCt	EIRP (dBW)

At intervals sufficient to ensure that the position is always up-to-date for the purpose of return-channel timing, either:

1) the external navigation device shall transmit the CBCt_POS_IND primitive; or

2) the BCtM shall send the CBCt_POS_REQ primitive, to request an up-to-date position. This will be answered by receiving the CBCt_POS_CNF primitive.

The parameters contained in the CBCt_POS_CNF primitive shall be used by BCtM:

1) For return-channel-timing.

2) To report to the Adaptation Layer via the CBCt_POSITION_CNF on the CBCt_SAP.

3) To calculate the forward and return Doppler frequency correction towards the satellite.

The BCtM shall send the CBCt_VELOCITY_REQ primitive, to request an up-to-date position. This will be answered by receiving the CBCt_VELOCITY_CNF primitive.

The parameters contained in the CBCt_VELOCITY_CNF primitive are provided to the Adaptation Layer via the CBCt_SAP to aid UE-initiated spot-beam selection.

The UE may send the CBCt_WAYPOINT_REQ primitive, which will be answered by the CBCt_WAYPOINT_CNF primitive. The parameters contained in the CBCt_WAYPOINT_CNF primitive may then be forwarded to the Adaptation Layer via the CBCt_POSITION_CNF on the CBCt_SAP in order to aid UE-initiated spot-beam selection.

5.2.3 Control Plane SAPs

5.2.3.1 STATUS-SAP Primitives and Parameters

The STATUS-SAP is the main control interface between the Connection and Control layer. It is used for the setting up of various BCt and for the reports of queue status for each bearer connection. The STATUS-SAP primitives are shown in Table 5.5.

Table 5.5: STATUS-SAP primitives

Primitive Name	Direction	Parameters
BCt_CREATE_REQ	To UE BCt	BCt-Type, BCnID, [tBCnID], BCtEPDU, BCtID
BCt_CREATE_CNF	To UE BCn	BCnID, tBCnID, BCt-DATA-SAP/BCt-UCDATA-SAP
BCt_MODIFY_REQ	To UE BCt	BCnID, [tBCnID], BctID, BCtEPDU
BCt_MODIFY_CNF	To UE BCn	BCnID, [tBCnID]
BCt_MODIFY_REJ	To BCn	BCnID, [tBCnID], Rejection Cause
BCt_CREATE_REJ	To BCn	BCnID, [tBCnID], Rejection Cause
BCt_DESTROY_REQ	To BCt	BCnID
BCt_DESTROY_CNF	To BCn	BCnID
BCt_COMCREATE_REQ	To BCt	COM_DH, Channel-No
BCt_COMCREATE_CNF	To BCn	COM_DH, BCt-COM-SAP
BCt_COMCREATE_REJ	To BCn	COM_DH, Rejection Cause
BCt_DATASTATUS_REQ	To BCt	BCnID, TimeFront, TimeEnd, QueueSize, NumSeg, HeadSize, UnSegmentable, RetryCount, SegStart, HeadChanged
BCt_COMSIGSTATUS_REQ	To BCt	UE_ID-type, UE_NAS_ID, TimeFront, TimeEnd, QueueSize, NumSeg, HeadSize, UnSegmentable, RetryCount, HeadChanged
BCt_HANDOVER_REQ	To UE BCt	BCnID, BCt EPDU, BCtID
BCt_HANDOVER_CNF	To UE BCn	BCnID
BCt_FAILURE_IND	To BCn	Failure Cause
BCt_TM_SECURITY_REQ	To BCt	Mode (Start / Modify), CK, START, SEQUENCE OF { BCnID, UL Activation Time, DL Activation Time }
BCt_TM_SECURITY_CNF	To BCn	SEQUENCE OF {BCnID}
BCt_TM_SECURITY_REJ	To BCn	SEQUENCE OF {BCnID}, Rejection Cause
BCt_CONFIGURE_IND	To BCn	CHOICE {BCnID, thp}, CHOICE{ AllocationSize, ResponseTime, MeanRate, TargetLatency, DiscardLatency}

BCt_CREATE_REQ primitive shall create the connection context at the bearer control. If the creation process is successful, then the tBCnID and the corresponding DATA-SAP associated with the given BCnID are returned using the BCt_CREATE_CNF message. Otherwise, a BCt_CREATE_REJ is returned with a cause code.

The BCt_COMCREATE_REQ primitive is used by the Bearer Connection Manager to signal the need to create a Common Signalling Bearer Control for a particular channel (specified by the channel-no parameter). If successful, the BCtM will associate the given Common Signalling Connection Handler (COM_DH), with the created Common Bearer Control (BCt-COM-SAP) and return its corresponding address using the BCt-COMCREATE-CNF primitive. Otherwise, a reject message BCt_COMCREATE_REJ is sent with the corresponding failure cause code.

BCt_DATASTATUS_REQ is used by the BCn Layer to send updated queue status information for each bearer connection to the BCtM. These included both UE Specific signalling channel and data channels.

The BCt_COMSIGSTATUS_REQ signal is the same as BCt_DATASTATUS_REQ except that it is used for the Common Signalling Channel. The BCnID is replaced by UE_ID-type and UE_NAS_ID as the identifier for the UE. Typically there will be no more than one PDU to be sent on the Common Signalling Channel at any one time. Furthermore, the PDU size is always shorter than the segment size and thus no segmentation is supported. Common Signalling Messages shall always be sent as a single segment by specifying the correct Unsegmentable parameter.

A UE can request a Handover by sending an Adaptation Layer message to the RNC. In this case, the Adaptation Layer in the RNC shall then request the LRM/RRM functions to service the handover. This is signalled to the Bearer Control Layer using the BCt_HANDOVER_REQ signal. The Adaptation Layer in the RNC may also initiate the Lease Mode Handover Procedure when the UE (subscriber) declares membership in a Lease Group. In that case, when the Handover message is received at the UE, the Adaptation Layer informs the Bearer Control Layer via the Bearer Connection layer using the BCt_HANDOVER_REQ primitive. Once the Bearer Control has completed retuning to the new bearer, the BCt_HANDOVER_CNF is sent to Bearer Connection layer.

BCt_FAILURE_IND is used to signal various types of failure to the Adaptation Layer, pipelined transparently via the Connection Layer, using a cause code.

The BCt_TM_SECURITY_REQ primitive is used by the Bearer Connection Layer to configure the ciphering parameters for all Transparent Mode connections. The Bearer Control Layer shall configure the specified TM connections with the corresponding CK and START parameters at the specified UL and DL Activation Time. Once all the TM connections are set up, the BCt_TM_SECURITY_CNF shall be returned to the Bearer Connection Layer. Any failure to configure any connection shall be reported via the BCt_TM_SECURITY_REJ primitive with the corresponding Rejection Cause code.

The BCt_CONFIGURE_IND primitive is sent to the Connection Layer when a BCt AVP is received that is specified to set a variable in the Connection Layer.

5.2.3.2 BCt-COM-SAP Primitives and Parameters

The BCt-COM-SAP is used for the transfer of Common Signalling data between Bearer Connection and Control layer. The BCt-COM-SAP primitives are shown in Table 5.6.

Table 5.6: BCt-COM-SAP Primitives

Primitive	Direction	Parameters
BCt_TxCOMSIG_REQ	To BCt	UE_ID-type, UE_NAS_ID, DataSize, AL-ComPDU
BCt_TxCOMSIG_IND	To BCn	DataSize
BCt_RxCOMSIG_IND	To BCn	UE_ID-type, UE_NAS_ID, DataSize, AL-ComPDU

The Common BCt Manager (COM_BCt_M) uses the BCt_TxCOMSIG_IND primitive to indicate the capacity available for the Common Signalling connection in the current frame to the Connection layer. The data handler (COM_DH) in the connection layer will respond by sending the address (UE_ID-type and UE_NAS_ID) and data (AL-ComPDU) to be sent using a BCt_TxCOMSIG_REQ signal. On the receive side, Common Signalling messages are delivered to the Adaptation / Connection Layer via the BCt_RxCOMSIG_IND primitive.

5.2.3.3 CBCt-SAP Primitives and Parameters

The CBCt-SAP is used by the Adaptation Layer to acquire a PSAB, GPS position data and System Information from the Bearer Control Layer. The CBCt-SAP primitives are shown in Table 5.7.

Table 5.7: CBCt-SAP Primitives

Primitive	Direction	Parameters
CBCt_DISCOVER_REQ	To BCt	ALPD, Global Discover Flag, SEQUENCE OF {PSAB Information}
CBCt_DISCOVER_CNF	From BCt	ALPD, PSAB Information
CBCt_DISCOVER_REJ	From BCt	ALPD, Rejection Cause
CBCt_POSITION_REQ	To BCt	ALPD
CBCt_POSITION_CNF	From BCt	ALPD, UE GPS Position
CBCt_POSITION_REJ	From BCt	ALPD, Rejection Cause
CBCt_SYSTEM_INFORMATION_IND	From BCt	ALPD, SEQUENCE OF {System Info Index Version, System Information AVP/SDU Set}
CBCt_AERO_HPA_REQ	From BCt	ALPD, Requested Power
CBCt_AERO_HPA_CNF	To BCt	ALPD, Allocated Power
CBCt_AERO_HPA_REJ	To BCt	ALPD
CBCt_AERO_HPA_IND	From BCt	ALPD, Returned Power

REGM from the AL will request the BCt layer to find and camp on the identified PSAB by using the CBCt_DISCOVER_REQ primitive. Where more than one PSAB is indicated, REGM requests the BCt layer to select and camp on the most suitable PSAB in the list. When successful, the BCtM confirms that it has camped on the identified PSAB via the BCt_DISCOVER_CNF message. Otherwise, the BCt layer indicates that it cannot find or camp on any of the identified PSABs using the CBCt_DISCOVER_REJ primitive.

CBCt_POSITION_REQ is used by REGM at the Adaptation layer to request the UE GPS position data from the BCtM. If available, the BCtM will pass the UE GPS position data to REGM using the CBCt_POSITION_CNF message. Otherwise, the CBCt_POSITION_REJ message is used to signal failure and specified reason. The BCt_SYSTEM_INFORMATION_IND message is used by the BCtM to pass received System Information with Adaptation Layer scope to REGM. The BCtM includes the version number corresponding to each broadcast System Information element (i.e. a set of AVPs or SDUs of a particular type).

On receipt of any request to create or modify a BCt handler for a signalling or data connection (e.g. receipt of BCt_CREATE_REQ at the STATUS-SAP), the BCtM shall first reserve HPA resources by sending the CBCt_AERO_HPA_REQ primitive to REGM. If BCtM receives CBCt_AERO_HPA_CNF with the *Allocated Power* parameter equal to the *Requested Power* in the CBCt_AERO_HPA_REQ message, then BCtM may proceed with the setup of the BCt handler (BCt_CREATE_CNF). If BCtM receives CBCt_AERO_HPA_REJ or CBCt_AERO_HPA_CNF with the *Allocated Power* less than the *Requested Power*, then BCtM shall return the *Allocated Power* (if any) using the CBCt_AERO_HPA_IND primitive and reject the setup or modification of the BCt handler (BCt_CREATE_REJ).

On receipt of any request to destroy a BCt handler for a signalling or data connection (BCt_DESTROY_REQ), the BCtM shall return the allocated power by sending the CBCt_AERO_HPA_IND primitive to REGM and proceed with the destruction (BCt_DESTROY_CNF).

6 Bearer Control Architecture

6.1 Bearer Control Architecture - UE Side

The Bearer Control architecture on the UE side is illustrated in Figure 6.1.

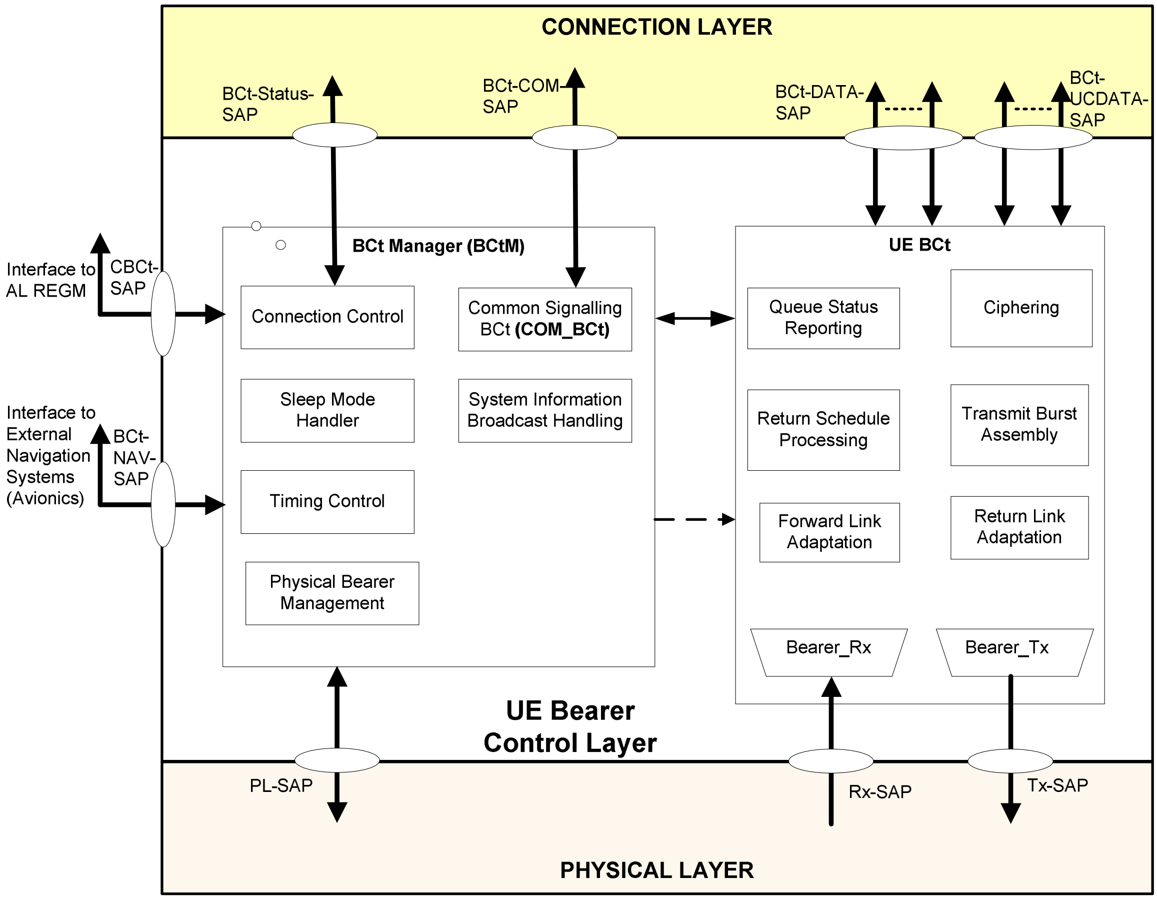

Figure 6.1: Bearer Control Layer - UE Side

6.2 Overview of Functional Entities in the Bearer Control Layer

6.2.0 General

The Bearer Control Layer on the UE side consists of the following entities:

- Control plane elements within the Bearer Control Manager (BCtM) comprising:
  - Connection Control

  - System Information Broadcast Handling unit
  - Timing Control
  - Physical Bearer Management
  - Common Signalling handling (COM_BCt) in the unit
- Connection and Bearer specific UE Bearer Control (UE_BCt) comprising:
  - Ciphering Function
  - Queue Status Reporting
  - Return Scheduling Processing
  - Transmit Burst Assembly
  - Bearer_Tx buffer
  - Bearer_Rx buffer

6.2.1 Bearer Control Manager (BCtM)

6.2.1.0 General

The Bearer Control Manager (BCtM) provides the main management interface to the Connection Layer above and to the physical layer below. It receives commands from the Connection Layer (via STATUS-SAP) to create or destroy bearer control units for each UE (UE_BCt). It also creates one data SAP (either BCt-DATA-SAP or BCt-UCDATA-SAP) for each bearer connection belonging to a UE, and associates it with the corresponding UE_BCt.

The BCtM also receives the queue status for each bearer connection via the STATUS-SAP. These will be passed to the Scheduling Control unit so that the resource usage can be determined. The BCtM will use the output of the Scheduling Control unit to determine when each UE_BCt will get the allocated resources.

The BCtM is responsible for receiving broadcast BCt PDUs and return schedules and uses them to configure the different bearers it is using. System Information is delivered to the AL via the CBCt-SAP. The CBCt-SAP is also used by the AL to start the search for the Primary Shared Access Bearer (PSAB).

The other functions BCtM include Timing control mechanisms for the mobile terminal.

6.2.1.1 System Information Broadcast Handling Unit

The RNC broadcasts a number of information elements to all UE in order to control how they access the system. The System Information Broadcast Handling unit is responsible for receiving and decoding this system information. It will maintain up-to-date system information and is stored in the BCtM for further use.

The Adaptation Layer specific System Information and NAS specific System Information is passed onto the Adaptation Layer for their use.

Any updates to the System Information will be notified by the RNC using the System-Info-Index SDU, in which case the UE will reacquire the modified system information.

This unit will keep an up to date record of all the system information.

6.2.1.2 Common Signalling Handler (COM_BCt)

The Common Signalling Handler (COM_BCt) manages the common signalling channel and interfaces to the Connection Layer via the BCt-COM-SAP. The architecture for the COM_BCt is illustrated in Figure 6.2. The Common Signalling Manager (COM_BCt_M) is responsible for handling all AVPs associated with the Common Signalling Channel.

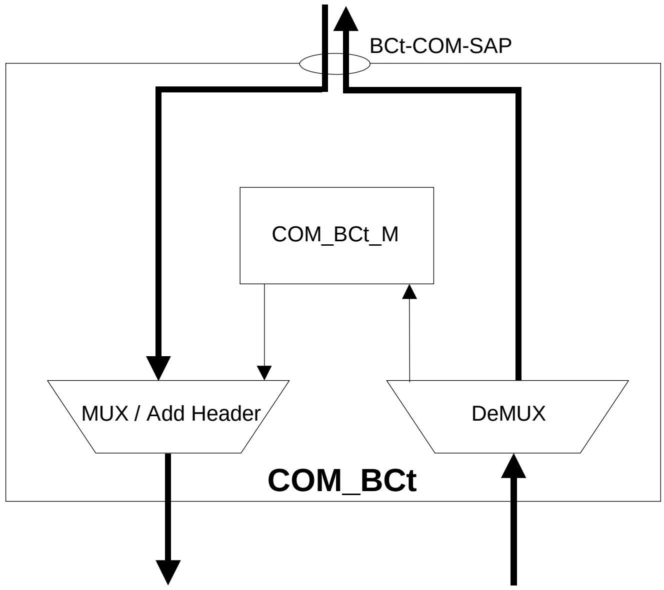

Figure 6.2: Common Signalling Handler (COM_BCt) Function

6.2.2 UE Bearer Control Unit (UE_BCt)

6.2.2.1 UE BCt User Plane Handling Function

The UE Bearer Control entity (UE_BCt) is responsible for the UE-Specific Signalling and all data connections associated with a particular UE. The architecture for the UE_BCt is illustrated in Figure 6.3. The connections that are given capacity to send data are signalled from BCt-M. The BCt Manager (BCt_M) will collect the allocated amount of data from the Connection Layer via various data SAPs and inject any AVP necessary to form the final BCt-PDU. Any received BCt-PDU will be routed to the correct Data SAP.

The UE_BCt will support a number of data SAPs, each mapped to a bearer connection associated with the UE. Two types of Data SAP are supported, namely BCt-DATA-SAP and BCt-UCDATA-SAP. The former is for Acknowledged Mode and Unacknowledged Mode connections where ciphering is completed in the Connection Layer. BCt-UCDATA-SAP is for Transparent Mode connections and requires ciphering at the Bearer Control layer.

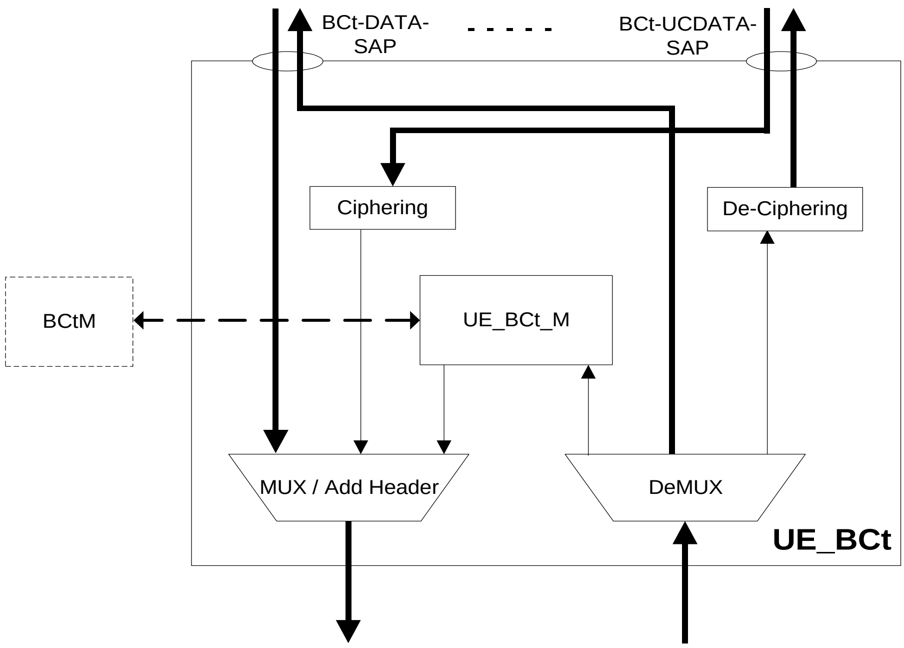

Figure 6.3: UE Bearer Control Unit Data Transfer Function (UE_BCt)

6.2.2.2 Queue Status Reporting

The Queue Status Reporting functional entity is responsible for generating reporting of queue status to the RNC for each connection. The behaviour for queue reporting is dependent upon both the type of Radio Access Bearer (RAB) connection and the type of signalling specified by the RNC, for instance the following applies:

1) Transparent RABs (for CS voice and ISDN) - no queue status reporting

2) Streaming RABs - queue status reporting periodically only during periods of inactivity

3) Interactive and Background RABs and UE signalling connection - queue status reporting for change of queue length or change in data rate requirement

4) Common signalling - no queue status reporting

The queue status signalling mechanisms include a Status SDU, for which there is a Status Ack (the Queue Status Reporting entity being responsible for tracking the association between Status SDU and Status Ack); and unacknowledged QueueLen and QueueRate SDUs used if instructed by the RNC and supported by the mobile terminal. The Queue Status Reporting function will generate queue status reports for processing by the Transmit Burst Assembly function when an opportunity to transmit next arises.

6.2.2.3 Return Schedule Processing

The Return Schedule Processing functional entity interprets the received Return Schedules and any Broadcast AVPs to determine the opportunity to send in any time-slot. It is responsible for creating a local description of the slots available for communication by the mobile terminal over a specific return scheduling period, and determines the frequency, timeslot and the bearer-type to be used.

The description of the time plan includes four categories of slots:

1) UE Specific Reserved Slots

2) Shared Reservation Slots

3) Controlled Random Access Slots

4) Contention Slots

There are strict rules for utilization of these slots within the mobile terminal, these rules being handled within the Transmit Burst Assembly process.

6.2.2.4 Transmit Burst Assembly

The Transmit Burst Assembly function controls the transmissions from the mobile terminal in the return direction, using the information provided by the Return Schedule Processing entity which describes the opportunities for the mobile terminal to transmit.

This entity then determines which of the connections (Common signalling, UE Specific Signalling Connection or Data Connection(s)) are allowed to transmit in each time-slot and constructs the bursts for transmission.

The Transmit Burst Assembly function is responsible for prioritizing information to send within each burst, and considers the following requests:

1) Common signalling information

2) Queue status reports generated by the Queue Status Reporting function

3) Link adaptation reports generated by the Forward Link Adaptation function

4) UE specific signalling information

5) User plane data from any supported connections

Where resources have been allocated to the UE, or a specific connection, then these will be utilized first, and if there remains a requirement to send additional information which has not been satisfied by the available resources, then the Transmit Burst Assembly function will determine whether it is allowable to transmit such information in Controlled Random Access or Contention capacity that may be available in the scheduling period.

6.2.2.5 Bearer Transmit Buffer (Bearer_Tx)

The Bearer Transmit Buffer shall collect the BCtPDUs from COM_BCt and UE_BCt and send them to the Physical layer for transmission on the physical layer.

6.2.2.6 Bearer Receive Buffer (Bearer_Rx)

The Bearer Receive Buffer collects from the Physical Layer all BCtPDUs decoded within a received FEC block and routes these to the System Information Broadcast Handling Unit, Scheduling Control, Common Signalling or UE Bearer Control as appropriate, for further decoding.

7 Bearer Control Management (BCT-M) Behaviour

7.1 Physical Bearer Management

7.1.1 Forward Bearer Configuration and Initial Bearer Scan

7.1.1.0 General

Prior to any communications taking place, it is necessary for the UE to acquire a Primary Shared Access Bearer (PSAB) suitable for communications in either a Regional Beam or Narrow Spot Beam. This requires that the UE perform an initial scan of the stored Global Beam frequencies, decode the System information, and then retune the hardware.

The Physical bearer management block within the BCtM is responsible for configuring the mobile terminal receiver channel units to receive the required physical bearers using information provided in the Broadcast System Information and Handover messages. The relevant System Information is provided to the AL REGM via the CBCt-SAP.

The Physical Bearer Management is responsible for carrying out Global Scan or Default Scan process when the BCtM receives CBCt_DISCOVER_REQ request via the CBCt-SAP from AL REGM. After successful acquisition of a PSAB, the scanning procedure is terminated and CBCt_DISCOVER_CNF primitive is sent to the AL REGM.

7.1.1.1 Global_Scan process

The Global_Scan process requests the Physical Layer (PL) to acquire individual Global Beam bearers in the specific order listed in the PSAB Information parameter. The used acquisition shall be *initial* (refer to ETSI TS 102 744-2-2 [7] for definitions of acquisition modes). The PSAB at the top of the list shall be scanned for firstly, followed by the second element. After a single list element has been scanned the first element shall be scanned again. Hence if the list consists of 16 Global Beam bearers, then the scan order shall be: 1st, 2nd, 1st, 3rd, 1st, 4th, 1st, 5th, 1st, 6th….1st, 16th. This scheme is required due to the relatively large time needed for the PL to establish that a physical bearer is not present at a certain frequency. (See *initial* acquisition specification in ETSI TS 102 744-2-2 [7]). After acquiring a Global Beam bearer the BCtM shall start looking for the *SatelliteLocation* AVP. When the correct AVP is found and the CRC is valid, then the global beam scanning is terminated, and the CBCt_DISCOVER_CNF primitive is sent to the UE AL. After a successful acquisition the PSAB list shall be updated such that the acquired global beam bearer is now on the top of the list, moving all other elements down one space. If no global beam bearer is found after scanning the full list, then the BCtM shall signal the CBCt_DISCOVER_REJ primitive to the AL.

For Class 1-3 UEs the control layer shall tolerate loss of physical bearer for up to 10 seconds before during the antenna-pointing mode (for instance this could be due to the operator repointing the antenna). After the user has terminated the antenna-pointing mode, the normal criteria for a bearer being lost apply. For all other UEs the termination of the antenna-pointing mode is replaced by an equivalent signal provided by the hardware equipment.

7.1.1.2 Default_Scan process

The Default_Scan process shall instruct the PL to perform a *warm* acquisition on all the PSABs in the list one by one. If one particular PSAB is not acquired through the *warm* acquisition mode then a *cold* acquisition shall be tried. After each successful acquisition the C/No is measured on 6 consecutive frames and the result stored. A successful acquisition is declared after two consecutive 80 ms frames have been received, and the CRC check of each of the PDUs in the first FEC-block in each frame has checked out OK. After all PSABs have been attempted/scanned, then the BCtM identifies the PSAB with the highest C/No. BCtM determines which spot beam that PSAB is in (using the Primary Bearer AVPs in the System Information) and calculates the number of alternative PSABs in that spot beam. If there are no alternative PSABs in that spot beam, then the BCtM instructs the PL to acquire the PSAB with the highest C/No. If there are one or more alternative PSABs, then the BCtM selects one of the PSABs in that spot beam at random (from the PSAB with the highest C/No and all the alternatives in the same spot beam), and instructs the PL to acquire it. BCtM then sends the CBCt_DISCOVER_CNF primitive to the UE AL. After the AL has been notified normal demodulation and decoding of the bearer commences. If no PSABs in the list were acquired successfully then the CBCt_DISCOVER_REJ primitive shall be signalled to the UE AL.

7.1.2 Forward Bearer Frequency Control within a Bearer Control

7.1.2.1 Retuning a population of UEs

The mechanism for retuning mobile terminals from one forward bearer to another within the same Bearer Control process is based on the use of the *ChannelNo* AVP. When a UE receives this AVP, it shall retune to the forward bearer specified. The *ChannelNo* AVP may be used whether the new bearer is within the same 200 kHz band or not. The UE shall determine whether or not this is within the same 200 kHz band.

Whenever the UE is retuned outside the 200 kHz subband (or handed over), the new forward bearer may not be time-synchronized with the old forward bearer, so the UE shall discard any return schedules received before the retune. Whenever the UE is retuned within the same 200 kHz subband (or handed over), the UE should honour return schedules that were transmitted on the previous forward bearer for the duration that these were valid, until a new return schedule is received on the new forward bearer.

7.1.2.2 Relocation of a specific UE

When the RNC relocates a specific UE to a new forward bearer within the same Bearer Control, all the connections associated with the UE are moved. This shall be signalled by using the *ChannelNo* AVP with the *Ack-Required* flag set to 1. The AVP can be sent using any active forward UE Connections. If all UE forward connection queues are empty, then the AVP shall be sent using the UE Specific Signalling Connection. This AVP shall be sent with all forward BCtPDU transmitted on the old frequency.

Once the UE has received the *ChannelNo* AVP with the *Ack-Required* flag set, it shall retune to the new frequency. After successful retuning the UE shall include the Forward Bearer Number field set to the new Forward Bearer in all bursts it sends to the RNC until it has received a UE-specific communication (either UE-specific signalling connection or a RAB-related communication) on the new forward bearer.

7.1.3 Forward bearer synchronization loss

Loss of forward bearer shall be signalled from the physical layer if no unique words are detected within a specified time, or detected by continuous CRC failure within the BCt layer (any instance of re-acquisition shall re-start this timer). If the current forward bearer is lost for a default 10 seconds (Land Class UEs) or 60 seconds (Extension Class UEs), the Physical Layer Management block shall signal this event to the Adaptation layer via BCt_FAILURE_IND, using cause code `NoForwardBearer`. In this requirement, the definition of "unique-word detection" depends on the Physical Layer implementation: some UE types may be able to reliably detect whether a UW is there or not for each UW, in which case this capability should be used. Other UE types may only discriminate between different UW possibilities, in which case detection of forward carrier loss rests on the CRC failure mechanism.

The UE may receive *BulletinBoard* information (RNC-ID, NetVer or BCt-ID, Spot-Beam-ID and Bearer Number) on the forward bearer that does not match those stored in the UE. If a value different from the one stored in the UE has been received on two consecutive occasions and the RNC-ID has not been updated due to an inter-RNC Handover, then the Physical Layer Management block shall signal this event as an error to the Adaptation via BCt_FAILURE_IND, using cause code `IncorrectForwardBearer`. If the value is no longer transmitted rather than changed (e.g. optional values like Spot-Beam-ID), then this shall not cause an error condition but the UE shall assume that the stored value continues to remain valid.

7.1.4 Forward bearer Doppler Compensation (Aeronautical Class UEs only)

At initial global beam acquisition, the Physical Layer Management block shall assume that the *SatelliteLocation* is the same as the stored position for that global PSAB, and it is exactly at the nominal position. This can lead to an error by up to 5 degrees (satellite inclination) in the direction of the satellite-vector - this shall be taken into account in the global beam frequency acquisition algorithm. In order not to affect regional beam acquisition, the state-vectors shall be broadcast by the RNC on the global beam *bulletinboard*. The global beam shall be broadcast on the same satellite as the regional beams to which it points, and therefore the Doppler frequency information gained on the global beam is applicable to the regional beam acquisition.

7.1.5 Return Bearer Doppler Compensation (Aeronautical Class UE Only)

An Aeronautical Class UE will typically impart a large offset in the carrier frequency it transmits as seen from the satellite, due to the Doppler effect. At up to 300 m/s, with an L-band receive frequency of ~1,642 GHz (middle of the band), this can represent up to +/- 1,6 kHz of offset. Therefore, the UE shall apply the negative of this offset to pre-compensate at the satellite. The approach by which the Doppler compensation may be calculated is presented in clause 9.2.

7.1.6 Return bearer frequency correction (Land-Mobile and Maritime Class UEs)

The Physical Layer Management block in the Land-Mobile and Maritime Class UEs shall measure the residual frequency error on their forward link, and apply a corresponding frequency correction to the transmit bursts to ensure that the frequency of the transmitted bursts shall be within the limits specified in ETSI TS 102 744-2-2 [7].

7.2 System Information Broadcast Handling

7.2.1 Storage of System Information

The UE shall store all system information on an RNC basis. For each rnc-id, the net-ver shall be stored, as well as all information elements, in Table 7.1.

7.2.2 Acquisition of System Information

At initial switch-on the UE shall await reception of the *SystemInfoIndex* SDU and all the broadcast system information elements (applicable to the UE Class and implementation options).

To ensure reception of critical system information by Low Gain Antenna (LGA) class mobile terminals, the RNC will transmit a replica of certain FEC blocks which will be transmitted sequentially on the global beam, and these UE shall include capability for combining the signals received associated with two adjacent FEC blocks prior to decoding. This mechanism shall be triggered for any two adjacent FEC blocks that are not successfully decoded. A recommended algorithm for combining data from adjacent FEC blocks is provided in ETSI TS 102 744-2-2 [7].

For all UEs, if information is repeated in two adjacent FEC blocks in the global beam and correctly received by the UE, then the repeated information should be ignored.

7.2.3 System Information Index - UE Behaviour

On receiving a BCtSDU the System Information Broadcast Handling (SIBH) entity shall:

- Decode BCtSDU of type BulletinBoard, compare the stored values of net-ver, f-bearer, bct-id and spot-beam-id received in the BulletinBoard SDU against that stored for the specified rnc-id and if any of these values have changed, update the stored value(s) and notify BCtM of the change. The SIBH entity shall also update the value of frame-no. If the Bulletin Board contains an optional *bb-avp-list*, then this AVP List shall be processed as specified below for AVPList.

- Decode BCtSDU of type AVPList (or a *bb-avp-list* is contained in a BulletinBoard SDU) and compare all values carried in the received AVPs against stored values and if any of these values have changed, update the stored value(s) and notify BCtM of the change.

- Decode BCtSDU of type SpotBeamMap.
- Decode BCtSDU of type BearerTables.
- Decode BCtSDU of type GPSEphemeris.
- Decode BCtSDU of type SystemInfoIndex.

In order to speed up subsequent initialization, all UEs shall record the *BulletinBoard* SDU, system information and corresponding *SystemInfoIndex* SDU in non-volatile memory for one or more beams (i.e. global beam and/or other beams). During subsequent initialization the UE shall determine whether it has an up-to-date record of the system information for the region in which it is operating. If he *SystemInfoIndex* SDU any element has been added or subtracted, or the version number changed or set to 0, the UE shall consider all stored information elements invalid and reacquire the latest System Information elements.

The UE shall only use the stored System information elements if the *SpotBeamID* is broadcast in the *BulletinBoard* SDU and that a corresponding System Information Element set is stored for this specific Spot Beam ID.

Some information elements may change value between beams (i.e. the scope is restricted to a single set of bulletin board parameters) while others may be common among all beams (i.e. scope applies to all forward bearers sharing the same RNC ID).

If the RNC-ID has changed during a Handover procedure, then the UE shall compare the *RNC-ID* received in the *BulletinBoard* SDU against the new value advised in a BCtEPDU sent in the AL Handover message. If the values do not match, then the UE shall delete all records of RNC dependent broadcast information (as per Table 7.1) previously received and receive them again. If the values match, then the UE shall store the new values of *RNC-ID* and *Net-ver* and then proceed as specified below.

If the *RNC-ID* or *Net-ver* have not changed, but any of *SpotBeamID*, *FwdBearer* or *BCtID* have changed then the UE shall consider all stored instances of those elements with BulletinBoard scope (as identified in Table 7.1) as invalid.

Table 7.1 indicates in which beams the broadcast information elements may appear. Note that changes to information elements with scope *RNC ID* shall cause the UE to update the value of those information elements in all locally stored system information records in which they appear.

Table 7.1: Broadcast System Information

Index-Parts	Index Bitmap Bit Number	Information Element	Type	Global Beam	Other Beam (regional, narrow)	Scope	Version Number Maximum Uniqueness Period	Version Number Bits	Instances Bit	Resulting Number of Octets in Si Index SDU	Type of Index Element
BitmapPartOne	0	Primary Bearer	AVP	YES	YES	BB	30 days	8	8	2	1
	1	SpotBeamMap	SDU	YES	YES	BB	30 days	8	0	1	3
	2	GPSEphemeris (covering both First and Second Section)	SDU	YES		BB	6 hours	8	8	2	1
	3	PLMNInfo	AVP	YES	YES	BB	30 days	4	4	1	2
	4	SatelliteLocation	AVP	YES	YES	Satellite	30 days	4	4	1	2
	5	SatelliteSateVectors	AVP	YES	YES	Satellite	Received if required	0	0	1	-
	6	UTCDateandTime	AVP	YES	YES	RNC ID	Received if required	0	0	0	-
	7	TimingCorrectionUpdateInterval	AVP	YES	YES	RNC ID	30 days	8	0	0	3
BitmapPartTwo	0	CommonSigRetry	AVP		YES	BB	30 days	8	0	1	3
	1	MaxdelayandDelayRange	AVP		YES	BB	30 days	8	0	1	3
	2	RandomisingCOntrol	AVP		YES	BB	30 days	8	0	1	3
	3	AccessControl	AVP		YES	BB	30 days	8	0	1	3
	4	InitialRandomAccessBurst	AVP		YES	BB	30 days	8	0	1	3
	5	GPSPolicyInfoParam	AVP		YES	BB	30 days	8	0	1	3
	6	NASSystemInfo	AVP		YES	BB	30 days	8	0	1	3
	7	ReturnBearerType	AVP		YES	BB	30 days	8	0	1	3
BitmapPartThree	0	BeamInfo	AVP	YES	YES	BB	30 days	8	0	1	3
	1	SubbandCentreFrequencyOffsets	AVP	YES	YES	RNC ID	30 days	8	0	1	3
	2	ForwardBearerTable	AVP	YES	YES	RNC ID	30 days	4	4	1	2
	3	BearerTables	SDU	YES	YES	RNC ID	30 days	8	8	2	1
	4	RandomisedInitialAceessDelay	AVP	YES	YES	BB	30 days	8	0	1	3
	5	IntermodTestInfo		YES	YES	BB	30 days	8	0	1	3
	6	reserved									
	7	reserved									
BitmapPartFour	0	Subband-Cf-Offset-Change	AVP	YES	YES	RNC ID	30 days	8	0	1	3
	1	Initial-Reference-Level	AVP	YES	YES	BB	30 days	4	4	1	2
	2	Leap-Second	AVP	YES	YES	RNC ID	30 days	8	0	1	3

Where specific information elements do not apply to a particular UE Class or a certain UE design optionally does not make use of specific information elements (e.g. UEs which do not make use of GPS Ephemeris), such information elements may be excluded from the determination that the UE has received a full set of system information.

A UE that has established that it has the full, up to date set of the information elements may immediately proceed from the global beam to a primary bearer (e.g. a regional beam advertised in a *PrimaryBearer* AVP) or if in a regional beam PSAB may proceed to register.

7.2.4 Wrap Around, Instances and Version Number Range

When a UE receives a *SystemInfoIndex* SDU it checks whether any information elements have different version number or number of instances to that recorded previously or whether any information elements have been added, subtracted or have a version number set to 0.

The UE shall determine whether there may have been a "wrap-around" of any information element's version number; this is established by consulting Table 7.1: Broadcast System Information (which is not broadcast but shall be stored in the UE). Note that if the version for a particular element is set to 0, then this indicates that the UE should always receive that element (if needed according to UE class). It is valid for the RNC to send different content in consecutive zero version information elements. This table lists each information element and the corresponding time over which that information element's version number is guaranteed to be unique. If available the UE should use the elapsed *UTCDateandTime* (as broadcast) to measure the interval between old and new *SystemInfoIndex* SDU. Alternatively, the UE may use its own internal clock or GPS.

If the version number is unchanged but the elapsed time between the current time and the time that the previous information element was recorded is greater than the version number maximum uniqueness period then the UE shall assume that the version number has "wrapped-around".

If a UE determines that an information element that it requires has been updated or added/subtracted (or the number of instances of these information elements has changed) or its version number may have "wrapped-around" or if the version number is set to 0, then it shall continue to listen to the bearer to pick up all instances of the corresponding information element (where the *instances* value denotes the number of unique instances of the information element that shall be received).

A UE shall interpret a value of *instances* when at its maximum value to be that value "or more", i.e. if the *instances* field is coded in 8 bits, then the maximum value of the *instances* field shall be interpreted as "255 or more instances".

If a UE determines that an information element in its previously recorded *SystemInfoIndex* SDU is no longer included then it shall delete its record of all instances of that information element for the beam in question.

As a UE is continually collecting instances of information elements which have their version set to 0, it shall identify an instance with a new value as a change in a previously collected element and discard all previously stored instances of that element. It shall then recollect all other instances of that element.

For example:

- An SI element with Adaptation Layer scope is being advertised with version 0 and instance 3.
- A UE which has previously collected and passed up to the Adaptation Layer instances A, B and C of this SI element, then sees a new instance D.
- At this point the UE shall hold the value D, and wait to receive 2 more instances of the element.
- The UE receives instances A and Y and then passes D, A and Y to the Adaptation Layer.

7.3 Common Signalling (Com_BCt) Procedures

Common Signalling is only used for the initial registration procedure. Prior to registration the UE may be untimed and will not have any link adaptation information. Specific procedures for access to the return channel apply during the initial common signalling operation.

Upon receipt of a request to utilize the Common Signalling Channel from the Adaptation Layer, the Com_BCt process requests access to the return bearer from the UE BCt process, and transfers information when an opportunity to transmit occurs.

Upon completion of the registration procedure, a UE-Specific-Signalling (UESS) Connection is established (referenced by an RNC-allocated Bearer Connection ID (BCnID). In addition, information is provided by the UE during the completion of the registration procedure regarding the UE capabilities, and should any the timing information be considered invalid, then a timing correction is provided by the RNC triggering operation in secondary timing mode.

7.4 Connection Control Operations

7.4.0 General

The following clauses cover the bearer control operations required when connections are established and released. It also covers the handover scenarios when connections are moved from one bearer control to another.

7.4.1 Connection Set-up Operations

The Embedded Bearer Control SDU (BCtESDU) is the mechanism that allows Bearer Control information to be carried within an Adaptation Layer message.

During the registration process, the ConnectionAssociation ESDU may be used to inform the UE of the assigned tBCnID for the UE Specific Signalling Connection. If a Connection Association is not provided, then the UE Specific Signalling Connection will operate in BCnID addressing mode. The UE may be instructed to change between BCnID addressing mode to normal tBCnID addressing mode using the Handover message even if the UE is being maintained on the current Bearer Control. To support operation in BCnID addressing mode, the UE will be instructed to utilize QLen signalling for UE the Specific Signalling Connection, this being accomplished by setting the qlen-based-signalling flag in the SlotSharingParam AVP within the ESDU carried in the Register Ack or Handover message.

When setting up a data connection, the ConnectionAssociation ESDU shall be embedded in the AL Establish message. If a Connection Association is not provided, the Data Connection will operate in BCnID addressing mode. For the any RAB to operate in BCnID addressing mode, the RNC shall instruct the UE to utilize either QLen or QRate signalling by setting one of the appropriate flags in the SlotSharingParam AVP within the ESDU carried in the Establish, Modify or Handover message.

The HardwareAVPList ESDU carries information for setting up the hardware channel unit in the UE. Three AVPs are valid in this ESDU, these being the ChannelNo, BeamInfo and SleepMode AVPs. An AVPList ESDU may also be used to carry general information that applies to the connection or UE Bearer Control. Both the HardwareAVPList and the AVPList ESDU can also be embedded as necessary in either a Register Ack, Establish, or Modify AL-SigPDU message.

7.4.2 Connection QoS Control

When a connection is requested by the UE, it shall specify a set of service QoS parameters required. Once accepted by the CN and higher layers, these are translated into Bearer Control QoS parameters. The final negotiated Bearer Control QoS parameters are signalled using the Type0QoS AVP.

Certain QoS parameters can be changed after connection establishment. These include response-time, return-mean-rate, return-target-latency and min-res-wait. The response-time parameter can be controlled after connection set-up by using the ForwardQoSControl AVP. The RNC may change the response-time for all UEs belonging to the same traffic priority class or an individual UE. The other 3 parameters can be adjusted by using the ReturnQoSControl AVP; the response-time parameter is used in the Connection Layer. The BcnType cannot be modified after connection set-up.

The means for modifying the Connection QoS is through the transmission of a Modify message. A Modify message may contain a Connection Reassociation SDU which does not include a tBCnID. In this case the UE shall operate such a connection with BCnID addressing mode. The RNC may reallocate a tBCnID to any such connection by transmitting a Modify message which contains a Connection Reassociation SDU with a tBCnID, after which the UE shall operate the connection in tBCnID addressing mode (for bearer types which support this mode of addressing).

7.4.3 Connection Release Operations

A connection release can be initiated by either the UE or the RNC. A connection can be released as a result of application closure, Bearer Connection or Control Layer error conditions.

In the Bearer Control Layer, the UE shall monitor the forward bearer while the UE is not in Sleep Mode. When the UE comes out of Sleep Mode and fails to detect the forward carrier, then the UE shall terminate Sleep Mode. It shall attempt to re-acquire the forward bearer and check updates to the system information. If it fails, then the connection shall be released.

7.4.4 Handover Operations

Bearer Connections may be handed over from one bearer control to another as result of:

- a UE moving from one spot beam to another; or
- a UE being moved from one bearer control process to another within the same beam.

The Handover message shall contain the reattached-conn-info-list and hardware-info-list ESDUs providing the new tBCnID, Channel-No and BeamInfo information to the UE. The new frequency to be used by the new UE Bearer Control shall be specified by the ChannelNo. The Beam Info AVP indicates the spot beam ID of the new spot beam. If there is a change in the Sleep Mode parameters, then these shall be signalled using the SleepMode AVP as part of the Hardware-info-list. Other Bearer Control information required for the Handover procedure shall include the ReturnBearerTypeParam AVP to specify the default bearer type on the new bearer and may include the MaxDelayAndDelayRange and ReturnLinkReferenceLevel AVPs if the Handover is between spot beams; these AVPs shall be sent in the same BCtPDU as the Handover message. The UE cannot distinguish inter-beam Handovers, therefore Initial Reference Level shall be set whenever the UE receives an AVP containing return link reference levels. Please refer to ETSI TS 102 744-3-1 [8] for details of usage of AVPs in BCtSDUs and BCtESDUs.

Once the UE receives a Handover message, the bearer control at the UE shall retune its forward bearer to the new channel as specified by the ChannelNo AVP within the Handover message. It shall also re-configure its BCt-ID and tBCnID for all the connections being moved. Once it has acquired the new forward bearer, it shall send the *HandoverAck* message in the UE Specific Signalling connection. If the *HandoverAck* message is lost, the normal Acknowledged mode connection behaviour shall ensure that it is retransmitted.

If a Handover message is sent with a Connection Reassociation which does not include a tBCnID, then that connection shall operate in BCnID addressing mode when operating on the new Bearer Control. The RNC may remove or reinstate tBCnIDs independently for either UE Specific Signalling Connections or RABs.

7.5 Timing Control Operation

7.5.1 Principles of timing control operation

The Return Channel Timing is derived from broadcast System Information elements and locally derived knowledge regarding the mobile terminal geographical location.

The UE receives state vectors on the forward link, which it uses to calculate the instantaneous satellite position. The state-vectors are calculated such that they describe an offset (x,y,z) from the nominal satellite position (see clause 9.3.1.3). The state vector AVP also contains an *interval* parameter that informs the UE in how many frames the next satellite state vectors will be broadcast.

The nominal satellite positions are broadcast in the Global Beam System Information, using the *SatelliteLocation* AVP. This AVP gives the nominal longitude of the satellite. The nominal altitude and latitude are fixed (42,164 Km and 0 degree).

Knowing the distance to the satellite, a UE calculates a self-imposed delay such that all UEs in a particular beam have the same round trip delay on the L-band link. Each beam will have a maximum round trip delay associated with it, due to the physical location of the spot on the earth. Depending on the SpotBeam-ID this round trip delay will vary. When all UEs have adjusted their timing offsets to precisely achieve the same round trip delay within a beam, the return channel is synchronized.

7.5.2 Primary and Secondary Timing Modes

The Return Channel Timing Control shall be implemented using two basic approaches:

Primary:

The Primary timing mode is essentially an open-loop timing correction method, and employs the satellite state vectors broadcast by the RNC using the *SatelliteStateVectors* AVP, together with geographical position estimates derived locally by the UE. These two information elements allow the UE to determine the timing advance (self-imposed-delay) to be applied at when bursts are transmitted, as specified in clause 9.

Secondary:

If the UE cannot establish its own geographical position to the required accuracy or if the "use-primary-rctc" bit in the "MaxDelayAndDelayRange" AVP is set to false by the RNC, the Secondary timing mode shall be used. This method is based on a "closed-loop" timing correction approach.

If the UE has no geographical position information, then it shall set its self-imposed-delay to zero always.

These UE shall transmit the first burst using an un-timed initial random access, specifying the slot in which it was attempting to transmit.

The RNC measures the timing difference between the time of the burst arrival and the slot boundary for the slot in which the UE was attempting to transmit. The UE is informed of this time difference using a "TimingCorrection" AVP. The UE shall use this value to adjust their "self-imposed-delay" to advance the timing by the amount necessary to achieve alignment at the RNC. The RNC will continuously monitor the timing drift of the UE and may instruct it to apply a different timing offset at any time using the "TimingCorrection" AVP.

7.5.3 Transition between Primary and Secondary Timing modes

If a UE, which is in Primary Timing Mode, receives a "TimingCorrection" AVP from the RNC with a magnitude greater than 120 microseconds, then it shall transition to the secondary timing mode.

7.5.4 Aeronautical Class UE without GPS

A special timing mode combining key aspects of primary and secondary timing shall be used for aeronautical terminals where GPS derived position data is not available, but position source with a slowly varying error is available (e.g. from an Inertial Reference System (IRS)).

For these UEs, initial transmissions to the satellite shall use untimed random access where the Self Imposed Delay is based on the IRS position. The RNC will measure and return the timing error. The UE will then start to operate in "Primary Timing" mode where the Self Imposed Delay is based on the computed time delay from the aircraft's position to the satellite and accumulated timing corrections from the RNC.

To help compensate for slow drifting of IRS system, the UE shall request a "Timing Correction AVP" from the RNC once every 2 minutes.

The UE is allowed to remain in "Primary Timing" Mode even if the timing correction returned by the RNC exceeds 120 µs. The UE shall continue to adjust timing according to the received "Timing Correction AVP".

If the Self Imposed Delay becomes invalid, e.g. when a UE accesses a new satellite, the process begins again with an initial untimed random access as described above.

7.6 Sleep Mode Operations

A UE is assigned Sleep Mode from the RNC via the Control Layer signalling during registration The information passed indicates the desired level of power saving to be achieved due to Sleep Mode operation. The desired level of power saving is dictated by a trade-off between the standby-time requirements and paging response times relative to the Core Network. This is translated into a set of control parameters by the RNC. These Sleep Mode control parameters may be modified by the RNC subject to the QoS requirements of individual connections, and are indicated to the UE using the *SleepMode* AVP. This AVP shall be sent as part of a BCtSDUList attached to Adaptation Layer signalling message - typically RegisterAck, Handover or Modify, but potentially in any BCtEPDU.

The RNC shall only consider the UE in Sleep Mode when the UE Specific Signalling Connection is the only connection established, i.e. all other data connections have been released. The UE shall not enter Sleep Mode if it has any connection other than the UE Specific Signalling connection active. Figure 7.1 illustrates the normal Sleep mode operation.

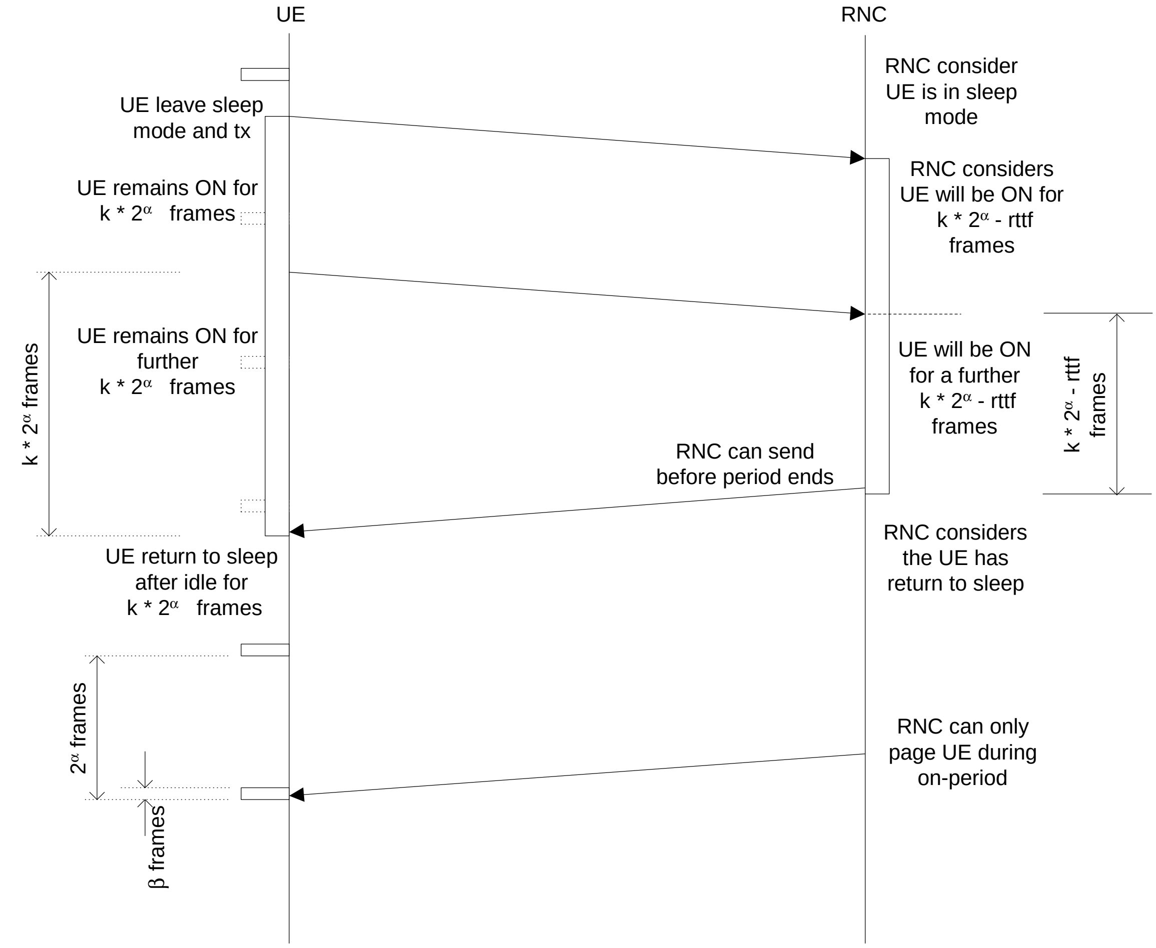

Figure 7.1: Sleep Mode operations

The set of parameters that are provided in the *SleepMode* AVP include the following:

- *start_offset*
- *logperiod* (α)
- *on_period* (β) and
- *idle-count* (k).

The *start-offset* parameter is used to determine the frame numbers when the Sleep Mode on-periods are to start. Since the frame number space (212 values) always divides into an exact number of Sleep Mode periods, the on-periods always start at the same frame numbers each time the frame number wraps around to zero.

The *on_period* (β) defines the minimum duration for which the UE shall receive the forward bearer. The UE shall receive the forward bearer with the following frame numbers:

$$start\_offset + n \cdot 2^{\alpha}$$

to

$$(start\_offset + n \cdot 2^{\alpha} + \beta - 1) \bmod 2^{12}$$

where n is an integer between 0 and $(2^{(12-\alpha)} - 1)$.

It is not essential for the UE to receive forward bearer frames with other frame numbers except for a time immediately following data sent from the UE (the idle-period).

A UE may temporarily leave Sleep Mode at any time, depending upon traffic characteristics. The end of Sleep Mode is defined by the transmission of any signal from the UE (this may simply be an acknowledgement to the RNC). Once the UE has left sleep-mode, it shall continuously receive the forward bearer for at least the idle-period. The idle-period is defined as ($k \times 2^{\alpha}$) frames. Any further transmission by the UE during the idle-period will cause an extension of the period for which the UE shall receive the forward bearer. If no transmission occurs within the idle-period, the UE may re-enter Sleep Mode operation. If the UE receives messages from the RNC, it shall finish processing the message before returning to Sleep Mode.

The UE shall not enter sleep-mode if it has data left in the transmission queue. Sleep mode is intended for use over long periods (many seconds). Sleep mode as defined in the present document refers to the behaviour of the UE as seen from the RNC (guaranteeing the ability of the UE to listen to the forward bearer on specific frames), rather than the specific switching off of individual UE elements. If there is data left in buffers within the UE for transmission to an external device, this would not come under sleep-mode. Similarly, sleep-mode as defined for the UE would not include data queues external to the UE and sleep-mode would not normally be enabled when higher-level protocols had remaining data.

A UE shall always leave the Sleep Mode if there are any frames during its on-period which it fails to decode. This could be the result of the frequency being removed while the UE is in Sleep Mode. Frame decoding failure is defined as: failure to detect the UW (implementation-dependent), or CRC failure in an FEC block, gated by the forward bearer code-rate.

The criterion for returning to Sleep Mode is the successful reception of the correct *BulletinBoard*. If the *BulletinBoard* is not received after 20 seconds, the UE shall initiate Forward Bearer re-acquisition. When the RNC considers that a UE is operating in Sleep Mode, it shall only transmit information to the UE during the on-periods.

The RNC shall consider the UE to remain in Sleep Mode until it receives a transmission from the UE (including an acknowledgement to RNC transmissions). At this point, the UE is considered to be receiving continuously until no data is received from the UE for the idle-period, which is equal to ($k \times 2^{\alpha} - rttf$) frames, where *rttf* is the round-trip time in number of frames. During this period, the RNC may transmit information to the UE at any time. If any message is received from the UE during this time, the idle-period shall be restarted. If no messages are received from the UE during the idle-period, the RNC shall consider that the UE has re-entered Sleep Mode.

8 Bearer Control User Plane (UE-BCT) Behaviour

8.1 Ciphering Operations

8.1.0 General

For Transparent Mode Bearer Connection PDUs, ciphering and deciphering is performed in the Bearer Control Layer.

Ciphering shall be implemented in accordance with ETSI TS 133 102 [1] and ETSI TS 133 105 [2], however, some minor modifications are required to accommodate the differences between UTRAN MAC and the satellite radio interface Bearer Connection Layer. Figure 8.1 illustrates the ciphering and deciphering process.

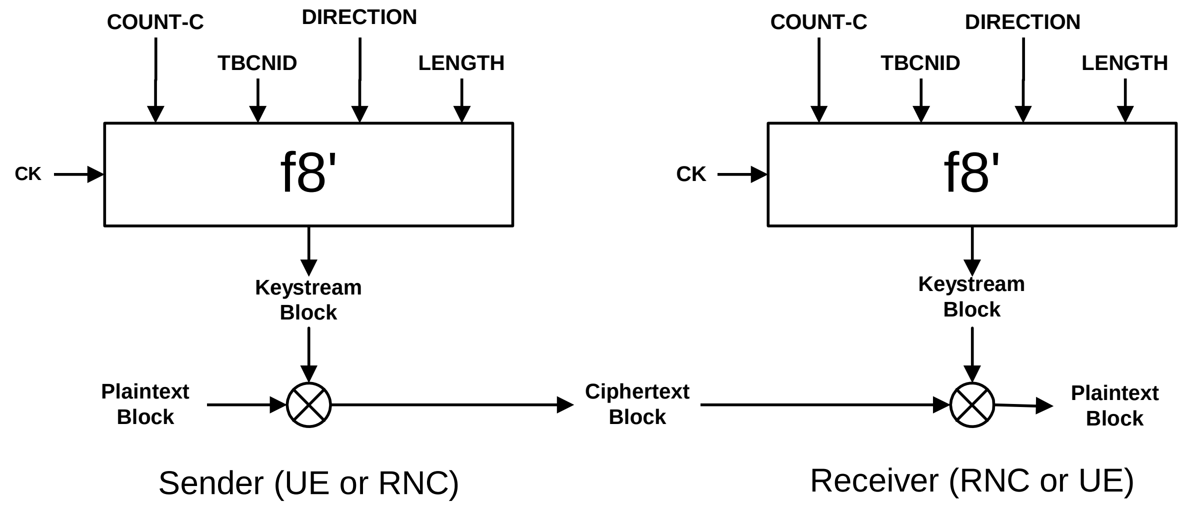

Figure 8.1: Ciphering of user and signalling data transmitted over the satellite radio interface

The standard UMTS KASUMI ciphering algorithm (f8) shall be used, however, the input parameters have to be modified such that its parameters are readily available in the satellite radio interface protocol. Hence, the algorithm is referred to as f8'. The parameters COUNT-C and TBCNID are modified to accommodate the satellite radio interface protocol, while all other input parameters are applied as specified in [1].

8.1.1 Input Parameters to the Ciphering Algorithm

8.1.1.1 CK

The cipher key CK is 128 bits long and shall be applied as specified in [1]. No modification is required for the satellite network.

8.1.1.2 COUNT-C

The ciphering sequence number COUNT-C is 32 bits long and is modified for the satellite network to reflect the counters available in the satellite radio interface protocol stack.

In Transparent Mode (TM) COUNT-C is composed as follows:

- The 16 least significant bits of COUNT-C consist of two parts: the 12 most significant bits are equal to the Frame Number (as transmitted in the Bulletin Board SDU and, for the return direction, derived as specified in ETSI TS 102 744-2-1 [6]), while the least significant 4 bits (shown as B in Figure 8.2) are determined as specified below. This part of COUNT-C is referred to in [2] as the *short* sequence number.
- The remaining 16 most significant bits of COUNT-C are incremented by one each time the *short* sequence number (Frame Number) wraps around. This part of COUNT-C is referred to in [2] as the *long* sequence number.

BCT-HFN (16 bits)	**Frame No. (12 bits)**	**B (4 bits)**

Figure 8.2: Structure of COUNT-C for Transparent Mode

There is one COUNT-C value common between connections on both forward and return links, defined by the synchronous frame numbering.

The value of B is determined as follows:

- On the forward link (downlink) B is the number of the FEC block in which the ciphered PDU is transmitted. The FEC block number count starts at 0 (i.e. one less than the FEC block numbering specified in ETSI TS 102 744-2-1 [6]).

- On the return link (uplink) B is the number of the slot in which the transmission of the burst starts and follows the definition of SlotNumber in ETSI TS 102 744-3-1 [8].

8.1.1.3 TBCNID

The translated bearer connection identifier TBCNID is 12 bits long and is available in the BCt-PDU header. This is used to replace the radio bearer identifier BEARER used in the UTRAN ciphering configuration.

8.1.1.4 DIRECTION

The direction identifier DIRECTION is 1 bit long. Its value is applied as specified in [1]:

DIRECTION = 0 for messages from UE to RNC

DIRECTION = 1 for messages from RNC to UE.

8.1.1.5 LENGTH

The length indicator LENGTH is 16 bits long. It specifies the length of the required keystream block in bits and does not affect the actual bits in the keystream block.

8.1.2 Initialization of Keystream Generator

The initialization of the keystream generator is specified in [3], clause 3.4 for UTRAN. In order to accommodate the input parameters used in the satellite network, the 64-bit register A shall be set to:

COUNT-C || TBCNID || DIRECTION || 0…0

(left justified with the right most 19 bits set to 0), such that:

A = COUNT-C[0]…COUNT-C[31] TBCNID[0]…TBCNID[11] DIR[0] 0…0

All other requirements of [3] remain unchanged.

8.1.3 Synchronization of ciphering

When ciphering of a new TM Bearer Connection is started, the 16 most significant bits of the Bearer Control Hyperframe Number (BCT HFN), shown in Figure 8.2, are initialized with the 16 least significant bits of the current value of the parameter START (see [1], clause 6.4.8). The timing of this initialization in terms of frame number is as defined below. Within the Bearer Control layer, ciphering only occurs in transparent mode, and ciphering is initiated at connection set-up.

The RNC AL will send a security mode command to the UE which (among other parameters) specifies the start of downlink ciphering (i.e. when the RNC starts to cipher). The start of ciphering is defined by the sending of a 12-bit value defining the frame number and FEC block number. To resolve the wrap-around ambiguity of the frame-number, the RNC shall ensure, and the UE shall assume, that the frame number sent will differ from the current frame number by less than 2 048. That is, if the (transmitted frame number minus current frame number) modulo 4 096 is less than 2 048, the hyperframe number on the receive side is initialized to START, otherwise to START+1.

The UE AL responds with a security mode complete which specifies the start of uplink ciphering (i.e. when the UE starts to cipher).

On the RNC side, ciphering is initialized after the Establish Ack message has been received.

During forward bearer handover between beams or 200 kHz bands, when the frame boundaries may be deliberately mis-aligned, and the acquisition of the new bearer has not yet seen the frame-no field in the BulletinBoard SDU, the frame number shall be assumed to be that of the old bearer frame with the boundary closest in time, either before or after, to the frame boundary (signalled by UW) of the new bearer.

8.2 Queue Status Reporting

8.2.0 General

In order for a UE to be allocated sufficient capacity to transmit either signalling or data messages, it needs to report its demand or queue status to the RNC.

Three signalling mechanisms exist for the purposes of providing queue status reporting:

1) Status SDU
2) QLen SDU
3) QRate SDU

All UEs shall support the Status SDU queue status reporting mode of operation. UEs compliant with RI-Version 0x83 (see ETSI TS 102 744-3-5 [12], clause 6.1.2.2) shall also support the alternative queue status reporting modes of operation. These alternate queue status reporting signalling mechanisms have been designed to be more optimized for low data rate services.

The RNC shall select the signalling mechanism to be used for the UESS or for any RAB using flags transmitted within the *SlotSharing* BCtAVP included in an Embedded BCtSDU associated with a Register Ack, Establish or Modify AL-SigPDU.

When the *constant-bit-rate* flag is set by the RNC, the UE shall not perform any queue status reporting mechanisms for that connection.

The *length-based-signalling* flag is set if the QLen SDUs are to be used as the soft-state requested-volume signalling mechanism instead of the acknowledged queue-length based Status SDUs.

The *rate-based-signalling flag* is set if the QRate SDUs are to be used as the soft-state requested-bit-rate signalling mechanism instead of the acknowledged queue-length based Status SDUs.

The rules for operation of each of these queue status reporting mechanisms are independent and separately specified in the clauses below.

8.2.1 Status SDU Queue Reporting Mechanisms

8.2.1.0 General

The UE is required to transmit status information on a regular basis on all packet-switched connections, except connections of type constant-bit-rate which shall not generate any Status SDUs. A Status SDU can be sent either in a contention or a reserved slot (Status SDUs are not used in Controlled Random Access or Shared Reservation modes).

If slot sharing is allowed as defined by the *SlotSharing* AVP (i.e. the "osa" bit set to TRUE), then a Status SDU for one connection can also be sent on a slot reserved for another connection belonging to the same UE. If the UE does not receive any reserved slots for the connection where a Status SDU is scheduled to be transmitted, then reserved slots on other connections shall be used. If no available reserved slots with spare capacity exist after certain time duration, then the UE shall use contention slots.

Hence the following priority exists for Status SDU transmissions:

1) Use reserved slots from the connection, which the Status SDU belongs to.
2) Use reserved slots from other connections if available resources exist.
3) Use Contention slots.

All Status SDUs are acknowledged by the RNC using broadcast type BCt-PDU containing one or more *StatusAckList* SDUs.

The Status SDU contains a sequence number and a set of queue status information. The *sequence-number* parameter shall be incremented each time a new Status SDU is generated. This is used by the RNC to acknowledge the Status SDU.

The following clauses also describe how the system variables affecting Status SDU generation shall be handled, and how queue status information shall be calculated.

8.2.1.1 Principle of Operation

The basic philosophy is to give the RNC all the information it needs to make the resource-allocation decisions. In principle, whenever the UE queue size changes, it would like to communicate this to the RNC. However, this would take up a lot of capacity on the return link, particularly since it is most likely to occur on contention slots. Therefore, calculations are made within the UE such that information is not sent either before the RNC needs to know (on the basis of QoS), or after it could in principle be used (due to round-trip delays).

The mechanism described here defines when the UE shall send Status SDUs to the RNC, on the basis of received return schedules and the present data queue status. The algorithm aims to:

- Send Status SDUs on reserved slots wherever appropriate because reserved slots are more efficient than contention slots.
- Reduce the sending of Status SDUs when the RNC is likely to allocate sufficient return channel slots within the next satellite hop period.
- Send updates to the RNC if the queue size decreases (e.g. because discard latency has been exceeded) but only when the RNC is not likely to have already allocated the capacity by the time it receives the status.
- Send updates to the RNC when urgent data has been put at the head of the queue.
- Allow the UE to share the capacity it is offered across its range of Bearer Connections in an effective way. Capacity sharing across PDUs can be restricted by the RNC by using the *SlotSharing* AVP.
- For the purposes of recovering from network congestion, provide a mechanism for the RNC to reduce the use of contention slots for all already existing connections at all UEs.

The first priority is always to ensure that the Status SDUs already sent have been received. As this is below the Acknowledged Mode connection layer functionality, a Status acknowledgement is implemented from the RNC, with a timeout in the UE. Because Status SDUs are often sent in contention slots, there is a back-off method implemented such that if collisions occur, the UE does not re-transmit immediately, but waits for a random time before re-trying, to increase the system stability.

The second priority is to ensure that previous Status SDUs have been acted upon. Given the negotiated QoS, the UE calculates the latest time by which it should have received a reservation. If it fails to see a reservation, then it decides to send a new Status SDU to update the RNC. This section also updates the queue parameters with the data at the time of sending the Status SDU.

The next priority is to decide whether a Status SDU needs to be sent out. Whenever new queue size information arrives from the Connection Layer, it decides when the latest time it could send this information to the RNC is, and still meets the QoS of the overall connection. The UE is inhibited from sending an updated Status SDU on contention slots until at least this time.

If reserved slots become available, it shall make a decision as to whether or not to transmit a Status SDU. This is based on the priorities above, plus whether or not the queue data has changed significantly or is very urgent. If so, the Status SDU is transmitted instead of some data capacity being offered to the Connection Layer (Criterion B).

If contention slots are available, it shall make a decision as to whether or not to transmit a Status SDU; in this case, the criteria are more stringent to prevent unnecessary usage of contention capacity (Criterion A). The UE is stopped from using contention slots before a certain time. Based on the QoS, it assesses whether the request is urgent enough to wait for the next expected reserved allocation for Status SDU transmission. It also estimates based on the QoS if the RNC is already allocating capacity at maximum rate, and if the Status SDU will reach the RNC in time to be worthwhile.

8.2.1.2 Data Status Update

The parameters required for constructing the Status SDU shall be derived from the latest BCt_DATASTATUS_REQ message received for the connection.

The Status information is provided by the Bearer Connection Layer to the Bearer Control whenever its queue changes, i.e. when:

- New data arrives in the connection layer data queue from the upper layer.
- Data is added to the queue for resending (ARQ data). This data may be added to the front of the queue and a new THeadDelivery time given to Bearer Control.
- Bearer Connection signalling data is added to the queue.
- Data is removed from the queue by the Bearer Connection because the Discard Latency has been exceeded.
- Data is removed from the queue by the Bearer Control (BCtTx_DATASTATUS is sent with the new queue information *before* BCtTx_DATA_req is sent).

8.2.1.3 Definition of QueueSize parameters sent by Connection Layer

The QueueSize parameters as sent from the Connection layer provide an estimate of the volume of data that need to be sent, including connection layer overhead: this calculation shall be carried out in the Connection Layer

$$QueueSize = NumSeg \cdot ConnSegOverhead + \sum_i PDUSize_i + \sum ARQSegSize + \sum SuperSegSize$$

$$NumSeg = \sum_i \left\lceil \frac{PDUSize_i}{AllocationSize - ConnSegOverhead} \right\rceil$$

where

PDUSize	is the size of a BCn PDU
AllocationSize	is set to [32] bytes by default, unless the *AllocationSize* AVP is specified
ConnSegOverhead	is the BCn segmentation overhead
ARQSegSize	is the size of each segment of data that will require retransmission
SuperSegSize	is the size of each BCn layer Supervisory frame.

The NumSeg parameter is an estimate of the total number of segments needed to transmit the queue including the connection layer overhead.

The ConnSegOverhead is the Bearer Connection segmentation overhead, which is defined as 3 bytes for an Acknowledged Mode Connection, 2 bytes for an Un-Acknowledged Mode Connection.

HeadSize is the size of the Data at the head of the queue. If the data is a BCnPDU then HeadSize is the size of the PDU. If the data is a segment that needs to be retransmitted, then HeadSize is defined as the size of that segment.

The parameter Unsegmentable is set to the minimum number of bytes that have to be sent together including BCn overheads. This refers to the data at the head of the queue. A value of zero means that data can be segmented arbitrarily, subject to a default minimum. Common Signalling Messages shall always be sent as a single segment by specifying the correct Unsegmentable parameter.

The parameter SegStart is a BOOLEAN set to true for segments that are the start of a PDU (i.e. bom or ssm BCnPDU), and FALSE otherwise.

The parameter HeadChanged is a BOOLEAN set to true if data at the head of the queue has changed (i.e. either TimeFront or HeadSize has changed) since the last DATASTATUS_req report.

8.2.1.4 Processing of Status Update

This procedure calculates CN.TReportTime whenever there is a change at the head of the queue. TReportTime is the earliest time this new Status information will normally be reported if a contention slot is used. First, LatestTime calculates the latest time that a Status SDU can be sent in order to still give enough time for the data at the head of the queue to be sent (assuming it is sent at the peak rate). If there is insufficient time, then that latest time is now.

Then ChosenTime is set between now and LatestTime based on ReportControl. A minimum bound is then placed to restrict the time between uses of a contention slot to MinContStatusDelay, and to increase the probability of usage of a reserved slot.

At initialisation:

Let CN.SelectedFrame = 0

end initialisation

Whenever BCt_DATASTATUS_req or BCt_COMSIGSTATUS_req signals are received, then, for a connection record, CN, identified by the BConnId parameter given in the BCt_DATASTATUS_req signal or by the UE_NAS_ID given in the BCt_COMSIGSTATUS_req signal:

Make a note of the new data received from the Bearer Connection layer.

Let CN.THeadDelivery = TimeFront (note when converting to STATUS SDU format the offset of 8 seconds to allow for communication of up to 8 seconds lag behind required QoS)

Let CN.TTailDelivery = TimeEnd

Let CN.HeadDataSize = HeadSize

Let CN.SegStart = SegStart

Let CN.Unsegmentable = UnSegmentable

Calculate how big the queue is taking into account the Bearer Control per segment overhead

Bearer Connection overhead already included in QueueSize in Connection Layer, as above

Let CN.ControlQ = QueueSize + (S.NumSeg × RetCtrlSegOverhead)

If CN.ControlQ = 0 then

Clear any reserved-slot timer running for this Bearer Connection

Let CN.RNCControlQ = 0

end if

if (HeadChanged = TRUE) then

Let LatestTime = max (Tnow, CN.THeadDelivery - (rtt × 1,5 + MaxAllocTime) - CN.HeadDataSize/CN.QoS.RetPeakRate)

Let ChosenTime = (LatestTime - Tnow) × BC.ReportControl + Tnow

Let CN.TReportTime = max (ChosenTime, CN.TLastTx + BC.MinContStatusDelay)

end if

end BCTx_DATASTATUS_req and BCtTx_COMSIGSTATUS_req signal processing

If sending a contention slot, initialize the frame randomization RandomisingLevel to 0 for the first attempt.

8.2.1.5 Status SDU Generation

8.2.1.5.0 General

The Status information shall reflect the status of the UE queue after the transmission of the data contained in the slot where the Status SDU was received.

Construct any Status SDUs that are required to be sent in this slot. For each Status SDU, SP, do the following (where BC is the Bearer Connection associated with SP):

Clear reserved-slot timer (for the Bearer Connection relating to the Status SDU)

If CN.ControlQ > 0 then

Let CN.reserved-slot-timer = TransmitTime +
max((CN.RNCTHeadDelivery − TransmitTime − 0,5 × rtt) × BC.ResWaitMultiplier,
CN.MinResWait × BC.ResWaitMultiplier)

This starts the reserved-slot timer

where TransmitTime is the start of transmission time of the slot being prepared.

(BC.RNCTHeadDelivery − TransmitTime − 0,5 × rtt) is the time by which the UE would
definitely expect a reservation; otherwise the UE can assume it has missed the reservation.
With default values the expression is dominated by MinResWait, except under congestion
conditions

end if

Let CN.StatusSeqNum = (CN.StatusSeqNum + 1) mod 16

Let SP.Q = CN.ControlQ

Let SP.THeadDelivery = CN.THeadDelivery − Tnow

Let SP.TTailDelivery = CN.TTailDelivery − Tnow

Let SP.DeliveryRate = CN.ControlQ / (CN.TtailDelivery - Tnow)

Let SP.SeqNum = CN.StatusSeqNum

If a Status SDU is sent in a contention slot, the retry-count field within the Status SDU shall be set to the RandomisingLevel used plus 1; if the SDU is sent on reserved capacity, it shall be set to zero

record the rounded-up values sent in the SDU

Let CN.RNCControlQ = SP.Q

Let CN.RNCTHeadDelivery = CN.THeadDelivery

Let CN.RNCTTailDelivery = CN.TTailDelivery

Let CN.RNCDeliverRate = CN.RNCControlQ / (CN.RNCTTailDelivery - Tnow)

Let CN.TStatusSDU = time-of-start-of-slot # Note the time when the status was sent

Let CN.StatusSDUCont = (not ReservedSlotFlag)

Clear status-ack-timer (for the Bearer Connection relating to the Status SDU)

if SP.Q != 0 then

Let CN.status-ack - timer = time-of-start-of-slot + rtt +
BC.TAckWait (to start the status-ack-timer waiting for the Acknowledgement)

NB where time-of-start-of-slot is the start of slot time excluding any delay imposed by the timing correction algorithms - i.e. the transmission time of the burst if the UE was transmitting in the slot and at edge of coverage

end if

Let CN.AckMissed = FALSE

Let CN.ResMissed = FALSE

end construction of Status SDUs

A connection might need contention slots for signalling of Status SDUs. The UE is only allowed to use contention slots if no available reserved slots exist which could carry the Status SDU. This feature is controlled by two Boolean criteria (A and B).

8.2.1.5.1 Criterion A

Criterion A is a large Boolean expression, which is used to control whether or not the UE is allowed to use contention slots for the Status SDU signalling.

The Criterion A is fulfilled if one of the following is true:

1) A *StatusAck* is missed from the RNC.

2) The reserved-slot-timer has expired.

3) The *TReportTime* has been exceeded and there has been a very significant change in the queue.

The very significant change to the data queue is declared if:

- New data has been added to the queue whereas the RNC expects the UE connection queue to be empty.
- Urgent data in the queue, for example ARQ segments.
- The queue has increased significantly compared to the current capacity allocation allows for.

```
Function Criterion A (BC) returns Boolean


Criterion A = (CN.AckMissed or
               CN.ResMissed or
               (Tnow >= CN.TReportTime and VerySignificantChange)) and
               NOT(CN.constant-bit-rate)


VerySignificantChange =   DataNowInQueue or
                          UrgentDataAtHead or
                          QueueIncreased


DataNowInQueue =          CN.ControlQ > 0 and
                          CN.RNCControlQ = 0
UrgentDataAtHead =        CN.ControlQ > 0 and
                          (CN.RNCTHeadDelivery − CN.THeadDelivery > CN.QoS.RetL × BC.LFrac and
                          max (Tnow + rtt × 1,5 + CN.HeadDataSize/CN.QoS.RetPeakRate,
                               CN.THeadDelivery) < CN.RNCTHeadDelivery)


QueueIncreased =          (CN.RNCControlQ > 0 and
                             roundup(CN.ControlQ/CN.AllocationSize) >
                          roundup(CN.RNCControlQ/CN.AllocationSize) and
                          CN.RNCControlQ < rtt × CN.QoS.RetPeakRate and
                             CN.TStatusSDU + (rtt × 2,5 + 2 × MaxAllocTime) + (CN.ControlQ −
                          CN.RNCControlQ)/CN.QoS.RetPeakRate > CN.TTailDelivery)
Roundup (x) = round x up to the nearest integer.
# Negative values are clipped to zero
```

8.2.1.5.2 Criterion B

Criterion B is used to determine if a slot shall be used for a Status SDU if the rest of the data queue fits into the slot (*DataSize* is the amount of data expected to be sent if the Status SDU is sent), given that the slot shall be used anyway. In addition, if a slot is a contention-slot, and the connection-layer data is labelled with a RetryCount value greater than zero, then a Status SDU shall be sent anyway, with queue-length parameters appropriate for after the burst having been sent.

Criterion B applies to slots which the UE has already decided to use: either a reserved slot, or a contention slot that Criterion A has specified is required to send a Status SDU. Criterion B determines if a Status SDU shall be sent in a slot like this, depending on how urgent a Status SDU is. If Criterion A has determined that a contention slot be used, but the data completely fits into the slot, then it may be that the data is sent instead of a Status SDU. The Status SDU contains the value of the queue-length after the burst has been filled.

```
Function CriterionB (CN, DataSize) returns boolean.


Criterion B =      (CN.AckMissed or
                   CN.ResMissed or
                   UrgentData or
                   QueueLarger or
                   QueueSmaller or
                   RetryCountForce)
                   AND NOT (CN.constant-bit-rate)
where
                   UrgentData = (SegStart) and
                      CN.RNCTHeadDelivery + DataSize/CN.RNCDeliverRate −
                   CN.THeadDelivery > CN.QoS.RetL × Lfrac
Where SegStart means the next segment to be transmitted is the start segment of a PDU


QueueLarger =      ((CN.RNCControlQ − DataSize) < rtt × CN.QoS.RetPeakRate and
                   roundup ((CN.ControlQ − DataSize)/CN.AllocationSize) >
                          roundup((CN.RNCControlQ − DataSize)/CN.AllocationSize)) or
                   ((CN.RNCControlQ − DataSize) >= rtt × CN.QoS.RetPeakRate and
                          CN.ControlQ − CN.RNCControlQ > CN.QDiff)


QueueSmaller =     (CN.RNCControlQ > rtt × CN.QoSRetPeakRate × BC.FracPeakDataVol and
                   roundup (CN.ControlQ/CN.AllocationSize) <
                          roundup(CN.RNCControlQ/CN.AllocationSize))


Roundup (x) = round x up to the nearest integer.
# Negative values are clipped to zero


RetryCountForce = (Slot is a contention slot) and
                        (having offered capacity to connections, the data returned has a Connection Layer
                     RetryCount value not equal to zero)
```

The Status SDU may also be used to carry the ReferenceLevelAck and ReceivedSignalQuality AVP, this behaviour being mandatory for UE Classes supporting ISDN. The behaviour associated with this use of the Status SDU is described in clause 8.6, Forward Link Adaptation.

8.2.1.6 Status SDU Control

8.2.1.6.1 Status Ack

All received Status SDU are acknowledged by the RNC using the *StatusAckList* SDU, which carries multiple StatusAck.

Whenever a Status SDU is sent, the UE shall start a *Status-ack-timer* with a timeout period of (*t-ack-wait* + *rtt*). If the timer expires before the *StatusAck* is returned, then the UE shall send another Status SDU and increment a counter for the number of un-acknowledged Status SDUs. The lost Status SDU is NOT retransmitted, but rather an up-to-date Status SDU shall be sent instead. If the maximum number of un-acknowledged Status SDUs (*MaxUnAckStatus*) is reached, then the UE shall report the failure to Adaptation Layer (using BCt_FAILURE_IND with cause code `MaxUnAckReached`).

The counter and Status-ack-timer shall be reset whenever a valid *StatusAck* is received.

When a recognised StatusAck is received:

If (SeqNum in Ack = CN.StatusSeqNum) and (Tnow >= CN.TStatusSDU + MinRTT) then

Clear the status-ack-timer for the appropriate Bearer Connection.

Let CN.UnAckStatusCount = 0

Let CN.RandomisingLevel = 0

Let CN.SelectedFrame = 0

end if

8.2.1.6.2 Status SDU Control Mechanisms

A number of system parameters control the operation of Status SDU. The two primary ones are:

t-ack-wait: default value 240 ms

MaxUnAckStatus: default value 8

These values can be changed by the RNC by using the *StatusAckControl* AVP. This AVP can be sent using the *SpecificAVPList* SDU or the *AVPList* SDU to signal the changes for a specific UE or to all UEs.

Other AVPs that can affect the operation of Status SDU are *MinResWait*, *FracPeakDataVolAndLFrac*, *ResWaitMultiplier*, *MinContStatusDelay*, *QDiff* and *ReportControl*. These AVPs are used by the RNC for controlling the behaviour of the UE when using contention slots and the sending of Status SDU.

8.2.1.6.3 Status Reporting Timers

Each Bearer Connection has the following timers, either or both of which may be running:

- Status-ack-timer: waiting for a Status Acknowledgement to the last Status sent
- Reserved-slot-timer: waiting for a reserved slot

```
If a timer CN. status-ack-timer expires then:

        Increment CN.UnAckStatusCount for the Bearer Connection.

        if StatusSDUCont then

# The last Status SDU was sent in a contention slot. It has not arrived and so the burst may

            # have collided with a burst from another UE. Need to randomise the next attempt and, if

            # already randomising, need to increase the randomising level (but not more than max).

            Let BC.RandomisingLevel = BC.RandomisingLevel + 1

        end if

        Let RandomisingLevelUsed = Min(CN.RandomisingLevel,BC.MaxRandomisingLevel)

            Let CN.SelectedFrame = random number between 0 and BC.FrameRandomiser ×
        2^(1 + RandomisingLevelUsed) inclusive


        If CN.UnAckStatusCount exceeds BC.MaxUnAckStatus then:

                give up on this Bearer Connection releasing the connection with a Control sub-layer protocol error
            (send MaxUnAckReached to Connection Layer via BCt_FAILURE_IND (see TS 102 744-3-3 [11])).

        else

            Let CN.AckMissed = TRUE for the Bearer Connection

        end if

        end status-ack-timer processing
```

```
If a CN.reserved-slot timer expires then:

# Note that the reservation has been missed for the Bearer Connection, BC associated with this reservation-slot-
timer

        Let CN.ResMissed = TRUE

end reserved-slot-timer processing
```

8.2.2 QLen SDU Queue Status Reporting Mechanism

The QLen SDU queue status reporting mode is an alternative approach to the use of the Status SDU for signalling the queue status for the UESS and background class RABs to the RNC. The QLen SDU does not require an acknowledgement from the RNC.

The QLen SDU queue status reporting mode shall be used if supported by the UE and explicitly signalled by the RNC setting the qls flag in the SlotSharing BCtAVP.

When operating in QLen SDU queue status reporting mode, the UE shall prepare a QLen SDU for transmission when the following applies:

1) If the queue was previously empty and newly presented data in the queue can be delivered within a single burst, then the UE shall not include a QLen SDU in the return burst.

2) If the queue was previously empty and newly presented data in the queue cannot be delivered within a single burst, then a QLen SDU shall be prepared for transmission within the next return burst suitable for carrying this SDU.

3) If the queue length has been previously reported, and the data has been added to the queue is greater than UpdateLen value specified in Table 8.1, then a QLen SDU shall be prepared for transmission within the next return burst suitable for carrying this SDU.

4) If the UE discards data from the queue such that the length of the discard data is greater than UpdateLen value, then a QLen SDU shall be prepared for transmission within the next return burst suitable for carrying this SDU.

5) If a retransmission is requested by the RNC (as the previous QLen SDU may have been lost).

In all cases the length of the queue indicated in the QLen SDU shall correspond to the QueueSize parameter as defined in clause 8.2.1.3, and shall correspond to the value that is calculated after transmission of data in this data burst.

The accuracy to which the QLen SDU can define the Queue Size is related to the length of the data held in the queue as defined in Table 5.7 in ETSI TS 102 744-3-1 [8]. Table 8.1 states the value of the UpdateLen parameter that is used to control the reporting mechanism.

Table 8.1: QLen Parameters

QLen Range	Update Len
00	256 octets
01	1 024 octets
10	4 096 octets
11	16 484 octets

The UE shall always round up the queue length to the next level in the quantization for the purposes of signalling to the RNC.

A QLen SDU shall always be included when transmitting bursts on ControlledRandomAccess bearers if the QueueSize value to be reported is non-zero.

8.2.3 QRate SDU Queue Status Reporting Mechanism

The QRate SDU queue status reporting mode is an alternative approach to the use of the Status SDU for signalling the queue status to the RNC. It allows the signalling of a perceived required rate rather than a queue length, this being more suitable for certain classes of applications that generate traffic on a continuous but fluctuating basis. The signalling mechanism has a low signalling overhead and is especially applicable for low data interactive rate connections. The QRate SDU does not require an acknowledgement from the RNC.

The QRate SDU queue status reporting mode shall be used if supported by the UE and explicitly signalled by the RNC setting the vbr flag in the SlotSharing BCtAVP.

When operating in QRate SDU queue status reporting mode, the UE shall prepare a QRate SDU for transmission when the following applies:

1) When operating in QRate queue status reporting mode, the UE shall transmit a QRate SDU when necessary (as defined below) and no more than one QRate SDU shall be incorporated for a single connection in any single burst.

2) The QRate SDU shall be included in the first burst transmitted by the UE after the connection has been established.

3) A QRate SDU shall be transmitted in subsequent bursts with a periodicity determined by the Update Rate in Table 8.2.

The QRate SDU is used to signal the observed rate at which data is being presented to the connection. This value shall be considered to have limited persistence in the RNC. Thus the UE shall periodically update the QRate information towards the RNC to ensure that resources continue to be allocated, with the period reducing as the rate increases, as shown in the Default Update Rate column of Table 8.2.

Table 8.2: QRate SDU Parameters

QRate Range	Update Rate
00	640 ms
01	320 ms
10	160 ms
11	80 ms

The UE shall always round up the observed rate to the next level in the quantization for the purposes of signalling to the RNC.

The rate is calculated by the UE as an average over the Update Rate interval. Once the observed rate increases above the current Rate Range, the UE initiates reporting at a new Update Rate as defined in Table 8.2. Once the observed rate falls below the current Rate Range, the UE initiates reporting at a new Update Rate, as defined in Table 8.2.

To calculate the parameter to be reported in the QRate SDU, the following applies:

QRate = ΔQueue/Interval

where:

ΔQueue = ∑NumSeq × ConnSegOverhead +∑ PDUSize + ∑ARQSegSize + ∑SuperSegSize

∑ = sum of new segments or bytes put into queue in Update rate interval

NOTE: ∑ shall not include segments or bytes taken out of queue

NumSeq, ConnSegOverhead, PDUSize, ARQSegSize, SuperSegSize defined in clause 8.2.1.3

Interval = Update Rate interval

8.3 Return Schedule Processing

8.3.1 General Concept of Operation

The Return Schedule Processing entity is responsible for creating the list of radio resources which represent the opportunity to transmit for the mobile terminal.

The Return Schedule Processing entity receives all Return Schedules as well as the ControlledRandomAccess and SharedReservationAccess Broadcast AVPs and compiles a list of all slots which represent an opportunity to transmit.

The Return Schedule Processing entity initially processes the list of tBCnIDs which are specified in the SharedReservationAccess AVPs. If there is a correlation with any temporary bearer connection which has been allocated to this UE, then the Return Schedule Processing entity will record all of the slots which correspond to this association.

The Return Schedule Processing entity then processes the list of tBCnIDs which are specified in the ControlledRandomAccess AVPs. The Return Schedule Processing entity then processes each of the Return Schedules, and categorizes the slots as follows:

1) Dedicated Reservation Allocations
2) Shared Reservation Access Allocations
3) Controlled Random Access Allocations
4) Contention Allocations
5) Reserved (Unused) slots

Dedicated Reservation Allocations of slot represents those for which a specific tBCnID has been allocated to this mobile terminal, whether for signalling or data connections. Dedicated Reservation Allocations are also used for High Data Rate (HDR) operation, in which case a Return Schedule is transmitted directly to the UE using a Connection-Specific BCtPDU, referenced by a tBCnID that is allocated to that UE.

Shared Reservation Access allow specific groups of UEs to access a shared resource, and are referenced using a two-stage lookup process to correlate a tBCnID allocated to a mobile terminal and presented in a Broadcast AVP with that used in the Return Schedule to define the resources to be shared.

Controlled Random Access Allocations define slots that represent an opportunity for immediate transmission of data in a Random Access Mode. A number of constraints are defined for utilization of these allocations in a Broadcast AVP.

Contention slots are available for contention utilization by UE - such slots are generally only used when no other resources are available for use by the UE.

Reserved (Unused) slots are not available for transmission by any UE, unless allocated to a specific UE for HDR operation using a Connection-specific BCtPDU.

If multiple allocations or opportunities to transmit occur within the same time-slot, the UE shall ignore any allocations that cannot be utilized during Transmit Burst Assembly processing.

8.3.2 Return Schedule Description

The distribution of the return channel capacity is described using the *ReturnSchedule* SDU. The SDU is transmitted on the forward link by the RNC at regular intervals, and describes the return capacity allocation for a single physical bearer over that specific period of time. A single Return Schedule is transmitted for each of the return bearers associated with a forward bearer. Each *ReturnSchedule* SDU describes the allocation for one particular bearer type, specified at its centre frequency (to a granularity of 1,25 kHz). Multiple *ReturnSchedule* SDUs are typically used to describe the combination of return bearers associated with each forward bearer. There is no association between forward and return sub-bands, and therefore Return Schedules describing physical bearers in multiple 200 kHz return sub-bands may be received by the UE on a single physical bearer in one specific 200 kHz forward sub-band.

If the UE receives a Return Schedule for a return channel for which a burst time plan has already been received, then the latest Return Schedule shall be considered to take precedence. This is only used to reallocate slots which were previously identified as Contention Slots to Dedicated Reservations. Any previous information shall be discarded and the process of determining the slots which are available for transmission shall be recalculated. It is guaranteed that there will be at least 80 ms between receipt of a *ReturnSchedule* SDU, and any slot to which it refers.

When Return Schedules operate on different return schedule periodicity for different physical bearers, then a reservation allocated in a Return Schedule may make it unnecessary for the UE to utilize contention slots which had been signalled at an earlier time on a different Return Schedule, and in such cases the latest reservation will take precedence over any previous decision to utilize contention slots. The Transmit Burst Assembly process should operate at the same periodicity as the shortest return schedule periodicity for the forward bearer to which the UE is tuned.

Figure 8.3 illustrates the scheduling control in a UE using a new schedule on the second bearer before the expiry of the old schedule on the first bearer.

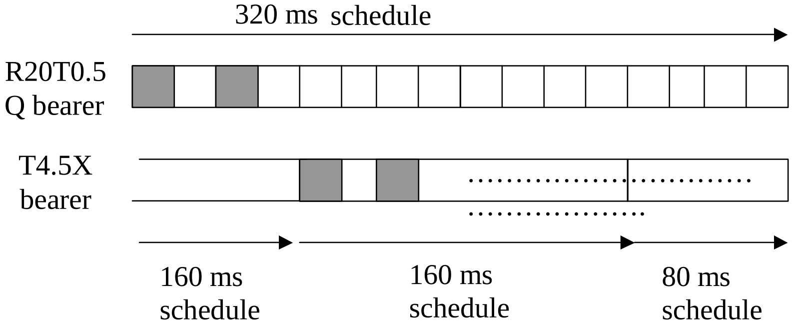

Figure 8.3: Illustration of Scheduling Control in a UE using new schedule on second bearer before expiry of the old schedule on the first bearer

8.3.3 Position of Return Schedules

The position of the return schedule within the forward frame is limited to certain FEC-blocks (0 or 4 for F80T4.5X-8B, 0 or 2 for F80T1Q-4B and F80T1X-4B, 0 for F80T1Q-1B, FR80T2.5 and FR80T5). The location in time of the return schedule transmission, together with its contents, defines the period in time to which it refers. Several combinations exist between forward bearer type, Return schedule type/length and Return schedule position. Figure 8.4 illustrates the relation between the forward bearer frame numbering and the return channel frame numbering.

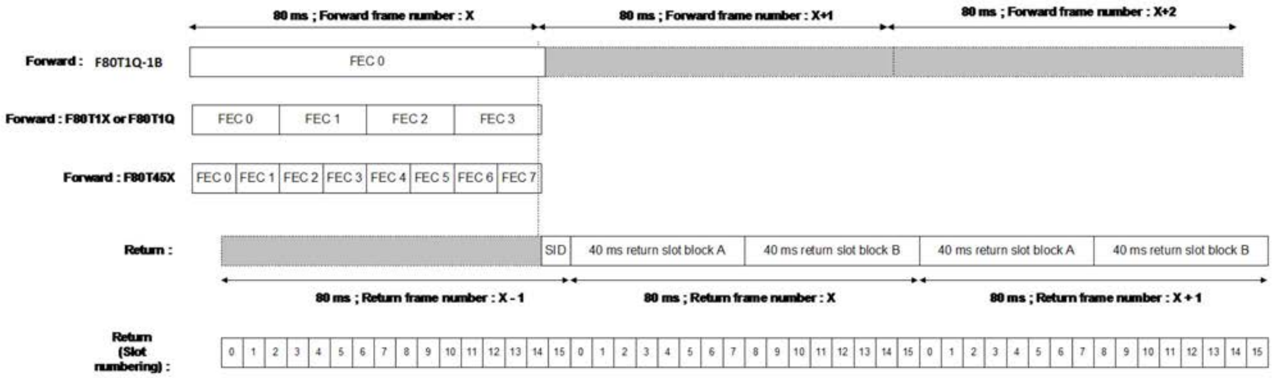

Figure 8.4: Return schedule validity at the UE antenna for non-interleaved forward bearers with return bearers using 40 ms Slot Plans

When operating with F80T1Q-1B, FR80T2.5, FR80T5 an additional frame delay is necessary to compensate for the 80 ms interleavers utilized with these forward frame structures.

The definition of the return channel timing for the R80T0.5Q-1B and R80T1Q-1B bursts depends on status of the cw80-acquisition-present flag signalled in the ReturnBearerTypeParam AVP by the RNC. If the cw80-acquisition-present flag is set to TRUE then a 79,52 ms preamble shall be transmitted by the UE before initiating an R80T0.5Q-1B or a R80T1Q-1B transmission. Also when the cw80-acquisition-present flag is set to TRUE, the return channel timing for R80T0.5Q-1B and R80T1Q-1B bursts is delayed by one frame (80 ms), to give the UE time to send a 79,52 ms preamble before the burst. The R80T0.5Q-1B and R80T1Q-1B return timing difference caused by the cw80-acquisition-present flag setting is illustrated by the examples in Figures 8.5 and 8.6. (Note that both these examples use 80 ms interleaved forward bearers. Also note that although it is not depicted in the figures below; it is possible to have outerinteleaved bearers as forward bearers with legacy bearers in the return direction and vice-versa).

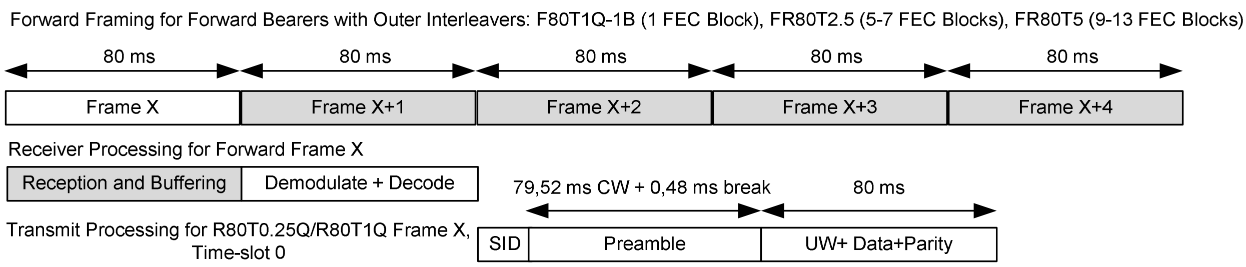

Figure 8.5: Return schedule validity at the UE antenna with Interleaved forward bearers and return bearers with 160 ms Slot Plans - with Preamble present

In the case Preamble is not transmitted, Figure 8.6 shows the return timing operation.

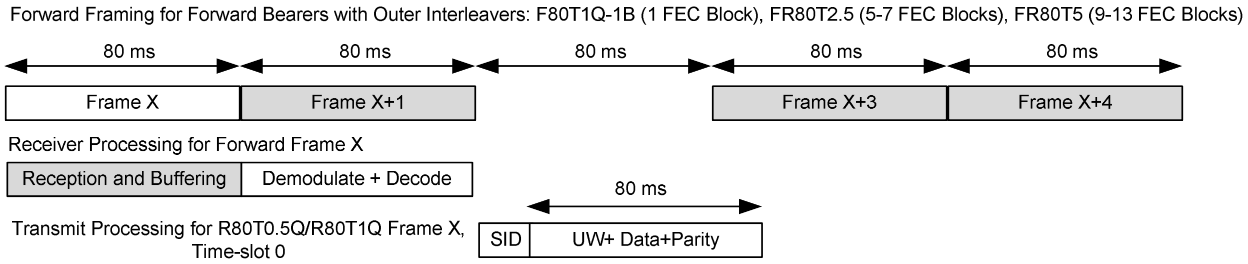

Figure 8.6: Return schedule validity at the UE antenna with Interleaved forward bearers and return bearers with 160 ms Slot Plans - with Preamble not present

In Figure 8.4, the return channel frame is sub-divided into 40 ms sections (A, B), for illustration purposes only. The actual air interface slot numbering is shown in the bottom line of the figure. The sub-division of the forward frame allows for a simple table to be used for describing the validity of the return schedule.

The Return Schedule may contain multiple slot plans, each of which describes a different period of time for a specific return bearer, as illustrated in Table 8.3.

Table 8.3: Slot Durations vs. Return Bearer Types

ReturnBearerTypeShort	Short Slot Duration (ms)	Long Slot Duration (ms)	Slot-Plan Duration (ms)	Valid Scheduling Periods (ms)
0, 4	20	80	160	160, 320, 480, 640
1-3, 5-7	5	20	40	40, 80, 120, 160
8-15	80	Not used	640	640, 1 280, 1 920, 2 560

When operating with F80T1Q-1B, FR80T2.5 and FR80T5 forward bearers, the 40 ms and 120 ms periods are considered invalid, and are never used. Return Schedules are only transmitted in the first FEC block in each of these forward bearers.

However, when operating with F80T1X/Q4-B and F80T4.5X-8B forward bearers, the 40 ms and 120 ms periods are considered valid for ReturnBearerTypeShort values in the range {0..7} inclusive, and since the forward frame timing is based upon a 80 ms frames, it is necessary to define the timing reference points for inclusion of a Return Schedule, in particular when a Scheduling Period describes 120 ms on the return bearer.

When scheduling resources for ReturnBearerTypeShort values in the range {8..15} inclusive, the Return Schedules for these bearers shall always be included in the first FEC block.

Table 8.4: Time of validity for the return schedule (when operating with F80T1X/Q-4B and F80T4.5X-8B forward bearers)

Forward Bearer type	F80T1X/Q-4B and F80T4.5X-8B			
Frame no. and FEC block no. for F80T45X containing the RS.	X, 0		X, 4	
Frame no. and FEC block no. for F80T1X/Q containing the RS.	X, 0		X, 2	
Return-bearer-type-short	0,4	1,2,3,5,6,7	0,4	1,2,3,5,6,7
Slot plan duration (ms)	160	40	160	40
Number-of-slot-plans = 1	X, A	X, A	X+1, A	X, B
Number-of-slot-plans = 2	X, A	X, A	X+1, A	X+1, A
Number-of-slot-plans = 3	X, A	X, A	X+1, A	X+1, A
Number-of-slot-plans = 4	X, A	X, A	X+1, A	X+1, A

Table 8.4 defines, for a given forward frame and FEC-block position (first block or middle block in a forward frame) of a Return Schedule, the position in time [RETURN FRAME, SUB-BLOCK] of the period to which it refers. A is the first half of a return-frame, whilst B is the second half of the return-frame.

In other words, if the *ReturnSchedule* SDU is in FEC block#0, it refers to a start time at the beginning of the identically-numbered frame in the return direction. If it is in the half-way FEC block, and only a 40 ms period is being referred to, it refers to the second-half of the same frame, otherwise it is the start of the next frame.

For example, for bearer-type F80T1X-4B where the Return Schedule (RS) is received in the middle FEC block (#2) and the return bearer-type-short is 0, and number-of-slot-plans=0, then the RS refers to the first half of the return frame numbered 1 greater than the forward frame number in which the RS was received. But if the bearer-type-short is 1 in this case, then the RS refers to the second half of the return frame with the same number as that in which the RS was received.

This ensures that there is always at least an 80 ms interval between the reception of a Return Schedule and its required implementation.

8.3.4 Dedicated Reservation Access

8.3.4.1 Dedicated Return Bearer (normal) operation

When a Return Schedule transmitted in a Broadcast BCtSDU defines slots as Reserved in a Slot Plan, and includes a tBCnID in the Resource Plan the UE shall include these slots in the list of Dedicated Allocations for processing by the Transmit Assembly process.

8.3.4.2 Reserved (Unused) Slots

The Return Schedule may define return slots as Reserved in a Slot Plan, but not provide a tBCnID in the Resource Plan. In these cases the UE shall ignore these slots.

8.3.5 Shared Reservation Access

The Shared Reservation Access (SRA) mode allows resources to be shared across multiple mobile terminals. This mode of operation is used by the RNC to allocate resources either on a pseudo-continuous basis to a mobile terminal for the purposes of satisfying a guaranteed or maximum rate for an interactive or streaming class radio access bearer, or for a specific controlled duration to allow the connection queue in a background or interactive class radio access bearer to be serviced quickly.

The Shared Reservation Access AVP is broadcast in either the Bulletin Board or as a Broadcast AVPList BCtPDU on the forward bearer. The Shared Reservation Access AVP will be transmitted before the matching return schedule SDUs.

For the purpose of utilizing the Shared Reservation Access mechanism, the mobile terminal shall have a signalling or data connection which has been allocated a tBCnId by the RNC.

The Return Schedule Processing entity, as specified in ETSI TS 102 744-3-1 [8], correlates the list of tBCnIds for connections maintained by the mobile terminal with the tBCnId in each of the Broadcast Shared Reservation Access AVPs. If it finds a match, then it records the association with the return-schedule-tbcnid that is specified in the Shared Reservation Access AVP, together with the parameters for the Shared Reservation Access, including the Reservation Duration and DTX Interval if specified. The DTX interval if specified is passed to the Queue Status Reporting process to override the default value for reporting.

The Return Schedule Processing entity then continues to process any Return Schedules received within the Reservation Duration period to determine whether any slots have been allocated to the Shared Reservation Access. Such slots are incorporated into a list of slots representing an opportunity to transmit within any scheduling interval, and made available to the Transmit Assembly entity together with the list of Physical layer control parameters. The derivation of a slot list for shared reservation operation is shown in Figure 8.7. The relationship between connection tBCnIDs and shared reservation access resources is many-one; a use case to illustrate the concept is depicted in Figure 8.7a. In this example, four tBCnIDs are allocated to four UEs with a one-to-one association. For each UE, a Shared Reservation AVP is transmitted, which in this case includes *tBCnID*, *ReturnScheduletBCnID* and *Physical Layer Parameter List* parameters. In the example, UE#1 and UE#3 are mapped to *Return Schedule A*, whereas UE#2 and UE#4 are mapped to *Return Schedule B*.

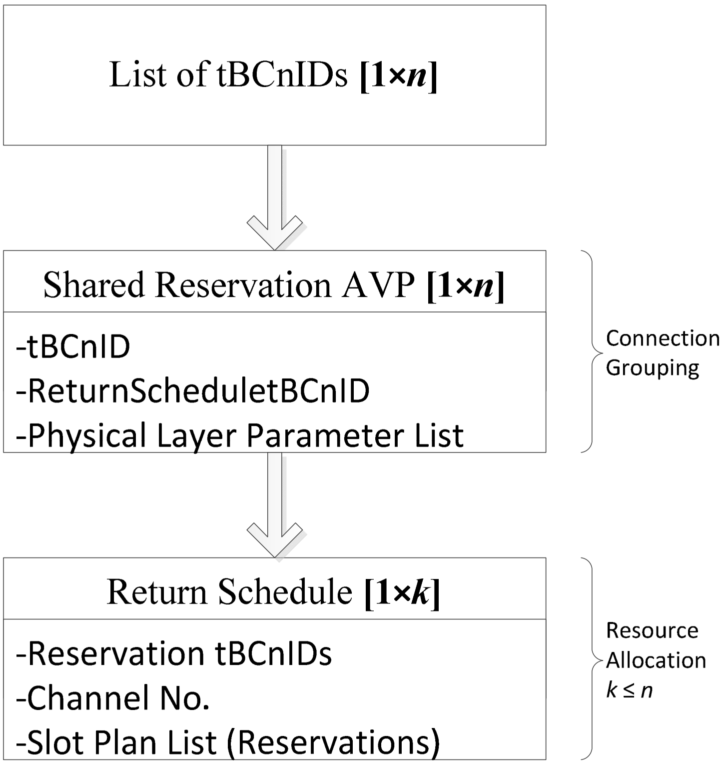

Figure 8.7: Shared Reservation Operation

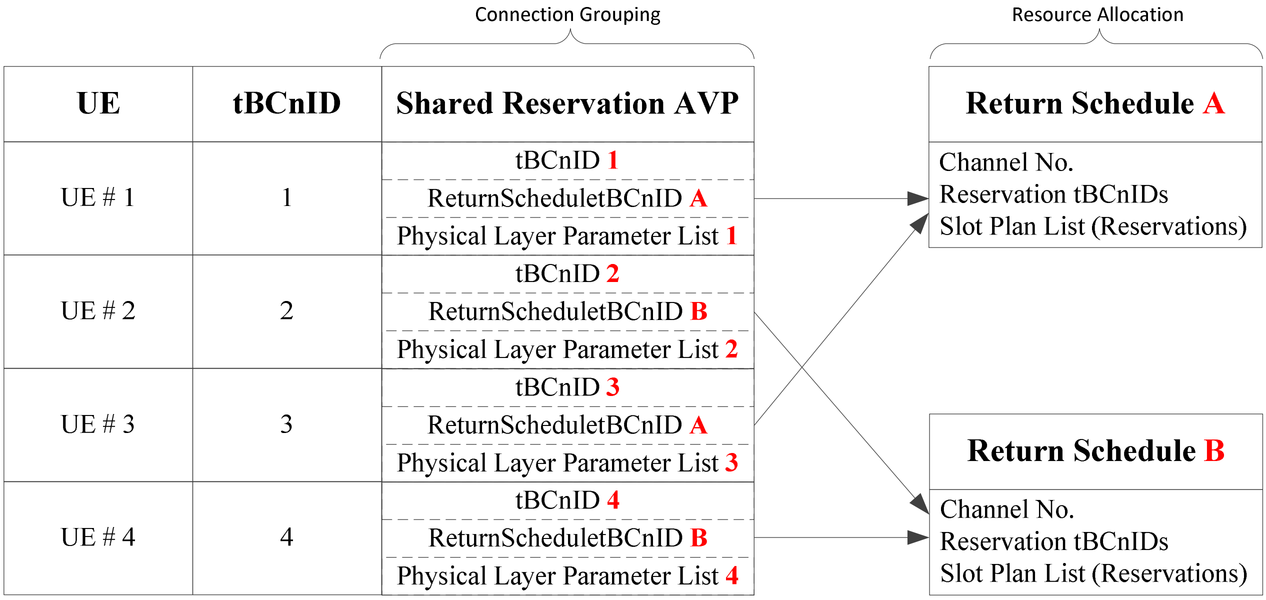

Figure 8.7a: Example of Resource Mapping for Shared Reservation Operation

The UE may receive multiple overlapping reservation allocations with different durations. In this case, the UE shall use the reservation with the highest effective capacity for the duration that reservation allocation is specified. Upon expiry of that reservation allocation, the UE shall continue to utilize allocations that have been defined with a longer duration, as shown in Figure 8.8.

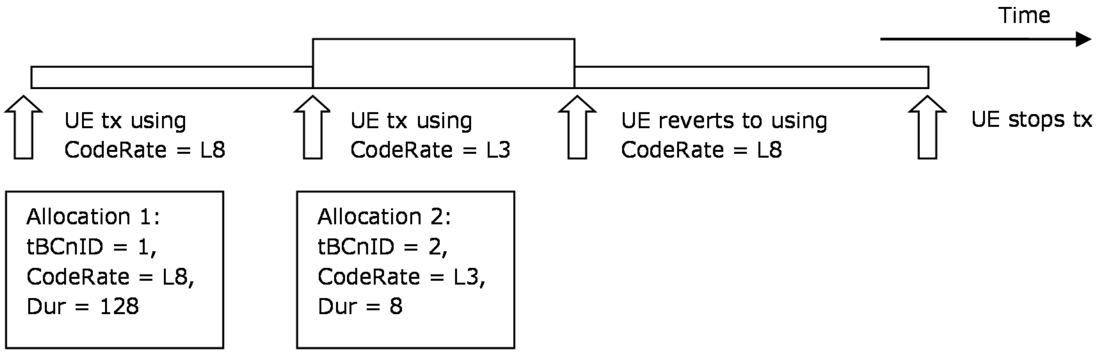

Figure 8.8: Shared Reservation Allocation: Multiple concurrent Allocations

A reservation allocation to a UE may be modified at any time to either modify the code rate, or increase or decrease the duration for which the reservation is valid. The mechanism to shorten the duration of the reservation allocation would typically be retransmitted several times to ensure receipt by the UE.

8.3.6 Controlled Random Access

The Controlled Random Access (CRA) mode of operation is used to provide a means of communication for mobile terminals that have not received Dedicated or Shared Reservation Access allocations. The Controlled Random Access bearers may be used for signalling or data communications. The definition of the Controlled Random Access radio resources and the control over access to the return bearer is determined by the RNC using information in a Controlled Random Access AVP that is broadcast on the forward bearer using an AVP List attached to a Bulletin Board, or in a broadcast AVP List BCtSDU. The CRA AVP will be transmitted before the matching return schedule SDUs.

The Return Schedule processing entity constructs the full list of available Controlled Random Access slots by correllating (i.e. matching) the list of tBCnIds in each of the Controlled Random Access AVPs with those in all of the Return Schedules. The control parameters for each slot are recorded in the list for processing by the Transmit Assembly process and Physical Layer entity. The derivation of a slot list for Controlled Random Access is shown in Figure 8.9.

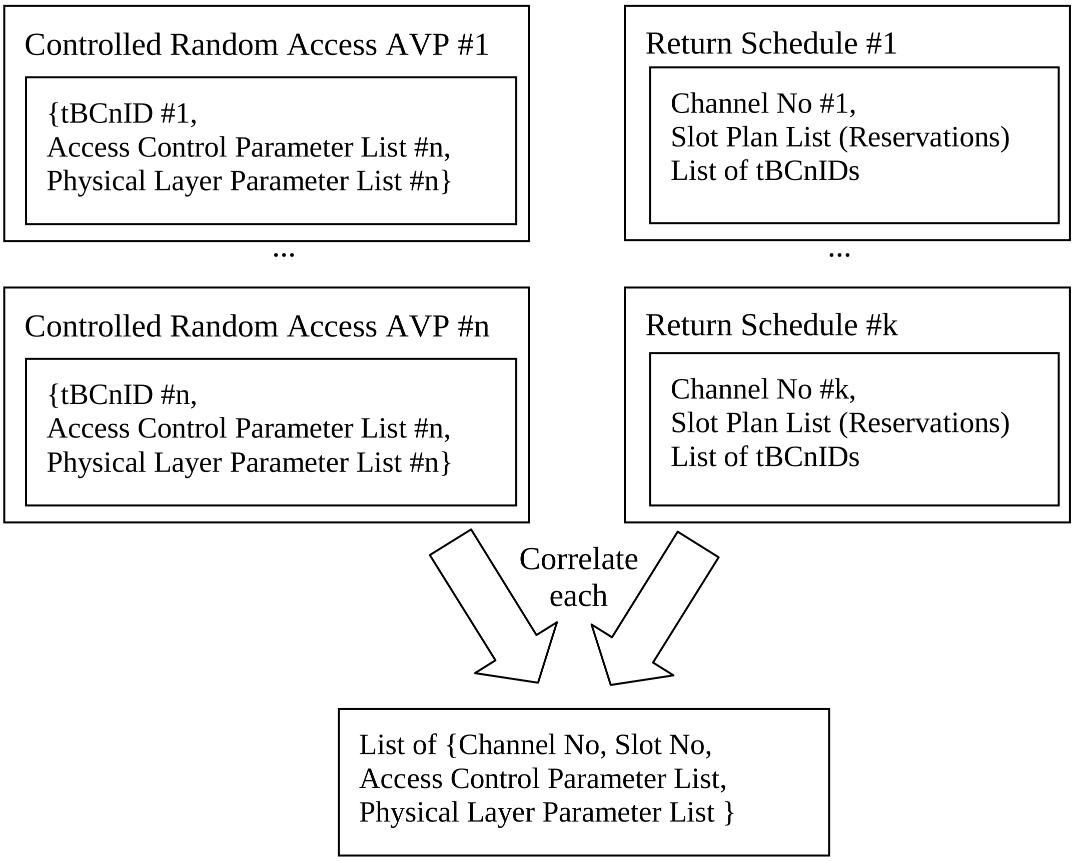

Figure 8.9: Derivation of Slot List for Controlled Random Access

The UE shall be able to store up to 32 CRA definitions at any time. A Controlled Random Access is valid for the same duration as the corresponding Return Schedules (associated to the Controlled Random Access AVP) transmitted. After the expiry of the duration, the CRA shall be deleted from the UE storage.

8.3.7 Contention Access

When a Return Schedule transmitted in a Broadcast BCtSDU contains Contention Slots, these are available for use by the UE if required, and shall be included in a list for processing by the Transmit Assembly process. A contiguous list of contention slots is required when the UE is operating in an untimed mode.

8.3.8 Dedicated Return Bearer (High Data Rate) operation

A Return Schedule transmitted in a Connection Specific BCtSDU is used to describe a Dedicated Return Bearer to a mobile terminal. This is accomplished by transmitting a Return Schedule using a Connection Specific BCtPDU, with the tBCnId being used to signal the connection for which the resources are being allocated. This approach is used only for Return Bearers FR80T2.5 and FR80T5. Any available timeslots to this connection are signalled as Reserved Slots with a Resource Plan included to indicate those slots which are available for transmission. Any unavailable timeslots are signalled as Reserved Slots with a Resource Plan indicating the slots which are not available for transmission. tBCnID lists are not included in the Return Schedule when carried in a Connection Specific BCtPDU, and an example of the Return Schedule construct is included in ETSI TS 102 744-3-1 [8].

8.4 Transmit Burst Assembly

8.4.0 General

When the UE is untimed mode, it may only transmit if either:

1) the UE is capable of using Low Data Rate (LDR) bursts, the RNC signals that LDR bursts may be used for Untimed Mode of operation, and Controlled Random Access Slots are available; or

2) if sufficient sequential contention slots are available to accommodate any timing uncertainty.

Once initial Timing Offsets have been calibrated and the UE is in Timed mode, the Transmit Burst Assembly algorithms process each of the categories of slots in turn as follows:

1) Dedicated Reservation Slots

2) Shared Reservation Slots

3) Controlled Random Access Slots

4) Contention Slots

The Transmit Assembly process operates on a per-time-slot basis, however for the purposes of accessing contention slots, the decision to utilize these is based upon the absence of any other resource that can satisfy a common signalling or queue status report for a connection in any return scheduling period, in which case the rules for determining which slot should be utilized are based upon randomization over all contention slots in a return scheduling period, on the proviso that the slot selected allows any physical layer constraints to be observed.

8.4.1 Usage of Dedicated Reservation Slots

8.4.1.1 Multiplexing of Data and Queue Status Reporting in Dedicated Reservations

When a return schedule is received containing a reserved slot for a specific connection handled by the UE, the reserved-slot timer for that connection shall be cleared. The system variable *ResMissed* shall be set to False for the active connection referred to by the return schedule.

A slot which is allocated to a specific connection may be used for signalling or other connections, conditional on the values of the *uess-takes-priority* (*utp*), *other-vbr-allowed* (*ova*), *other-cbr-allowed* (*oca*), *other-data-allowed* (*oda*) and the*other-status-allowed* (*osa*) flags specified by the RNC in the *SlotSharing* AVP.

In addition, the *qlen-based-signalling* (*qls*), *variable-bit-rate* (*vbr*), and *constant-bit-rate* flags are used to inform the BCt in the UE of the expected behaviour with regard to both the type of signalling and the utilization of any dedicated reservations.

The *constant-bit-rate* parameter is implicitly TRUE for Transparent mode connections, FALSE for Acknowledged mode connections, and as defined by the *constant-bit-rate* flag in the SlotSharing AVP for Unacknowledged (Numbered) mode connections.

Connections of UMTS-class Conversational (typically 4 kbit/s voice or ISDN) are always implicitly considered to be of type constant-bit-rate and operate via Transparent mode BCnType connections.

For slots associated with *constant bit rate* connections the UE shall create the burst according to the following rules:

```
if (utp) then
        include QstatusReport or AVPList SDU for UE Specific Signalling connection if necessary
        if (UESS ControlQ>0) then
            include Data from UE Specific Signalling connection
        endif
endif
if (ControlQ>0 for specified connection)
    fill Data for specified connection
endif
if (oca and space-left-in-slot)
    include Data from other CS connections of type constant-bit-rate with ControlQ>0
    include Data from other PS connections of type constant-bit-rate with ControlQ>0
endif
if (ova and space-left-in-slot)
    include QstatusReport and/or Data from other connections of type variable-bit-rate with
        ControlQ>0 up to mean rate specified in the Typ0QoS AVP
endif
if (ova and space-left-in-slot)
    include QstatusReport and/or Data from other connections of type variable-bit-rate with
        ControlQ>0 up to peak rate specified in the Typ0QoS AVP
endif
if (oda and space-left-in-slot)
    include QStatusReport and / or Data from UE Specific Signalling connection
    include QStatusReport and/ or Data for connections not of type constant-bit-rate
endif
if (osa and space-left-in-slot)
    include QStatusReport from UE Specific Signalling connection
    include QStatusReport from other connections not of type constant-bit-rate
endif
```

If no data or QStatusReport need to be sent, then the UE shall transmit a burst consisting of nothing but zero-padding.

For connections not identified as *constant-bit-rate* the UE shall fill create the transmit burst according to the following rules:

```
if (utp and UESS ControlQ>0 then
    include Data from UE Specific Signalling connection)
endif
if (ControlQ>0 for specified connection )
    include QStatusReport from UE Specific Signalling connection if necessary
    include QStatusReport from specified connection report if necessary
fill Data for specified connection
else
if (not vbr)
    include QStatusReport from specified connection
endif
if (oca and space-left-in-slot)
    include Data from other CS connections of type constant-bit-rate with ControlQ>0
    include Data from other PS connections of type constant-bit-rate with ControlQ>0
endif
if (ova and space-left-in-slot)
    include QstatusReport and/or Data from other connections of type variable-bit-rate with
        ControlQ>0 up to mean data rate specified in the Typ0QoS AVP
    include QstatusReport and/or Data from other connections of type variable-bit-rate with
        ControlQ>0 up to peak data rate specified in the Typ0QoS AVP
endif
if (oda and space-left-in-slot)
    include Data from UE Specific Signalling connection
    include QStatusReport from connections not of type constant-bit-rate if necessary
    include Data for other connections not of type constant-bit-rate
endif
if (osa and space-left-in-slot)
    include QStatusReport from UE Specific Signalling connection
    include QStatusReport from connections not of type constant-bit-rate
endif
if (space-left-in-slot)
    include QStatusReport and/or Data for specified connection
endif
```

In all cases above, QStatusReports (QStatusReports comprise either a Status SDU, QLen SDU, or QRate SDU as specified by the RNC) for any connection are only included if they meet the criteria for reporting as specified in clause 6.2.2.2 Queue Status Reporting, for each type of Queue Status Reporting mechanism.

The UE shall not multiplex data from a *constant-bit-rate* connection into a slot allocated to a dedicated slot allocated to an Interactive or Background Class connection unless the *other-cbr-allowed* (*oca*) flag is set.

When multiplexing traffic from multiple non *constant-bit-rate* connections into a burst allocated another connection, the UE shall start with the Interactive connections with the highest Traffic Handling Priority, and end with the Background class connections.

The mobile terminal shall handle all connections of the same type and Traffic Handling Priority in order of highest to lowest RAB Access Priority.

The UE shall handle all connections of the same type, Traffic Handling priority and RAB Access Priority on a Round-Robin basis for any connections with a non-zero queue-length.

8.4.1.2 DTX Operation

This clause is optional for implementation in the UE, and is intended to reduce power consumption when there is no data to transmit. If implemented, the UE shall comply with all of the requirements in this clause.

For connections of type "constant-bit-rate" the UE does not need to transmit a burst in every allocated slot, provided that it is not using Continuous Transmission Mode Bearer types. However the UE shall transmit at least one DTX burst per second, consisting of QStatusReports (QStatusReports comprise either a Status SDU, QLen SDU, or QRate SDU as specified by the RNC) indicating a zero queue length using a BCtPDU specific to the reserved connection.

8.4.1.3 Enhanced ISDN Data Transmission

Mobile Terminals shall be capable of packing either two or four User Data Frames of ISDN data within an allocated reserved slot. User Data Frames of ISDN data are 80 octets long (see ETSI TS 102 744-3-9 [10]). The exact number of User Data Frames to be packed shall be derived from the size of the FEC return block provided to the specific connection and the value of *ReturnCSFramesPerPDU* (see ETSI TS 102 744-3-9 [10]).

If the block size is ≥ 2 × (160 octets + BCtPDU header size with timing bit set) and *ReturnCSFramesPerPDU* = 4, it shall transmit four ISDN User Data Frames, otherwise it shall transmit only two.

The RNC will ensure that it allocates reservations to the connection such that their usage is predictable and maintains the correct transmission rate. Figure 8.10 shows an example of how this may operate.

To ensure the payload of BCtPDUs always aligns with an 80 octet boundary of an ISDN frame and does not exceed the maximum payload size, the Bearer Control Layer shall always report a need to fill 160 octets to the Bearer Connection Layer. ISDN data is then delivered to the Bearer Control Layer as a TM_BCnPDU. The process shall be repeated if the above criteria for transmitting four ISDN User Data Frames are met.

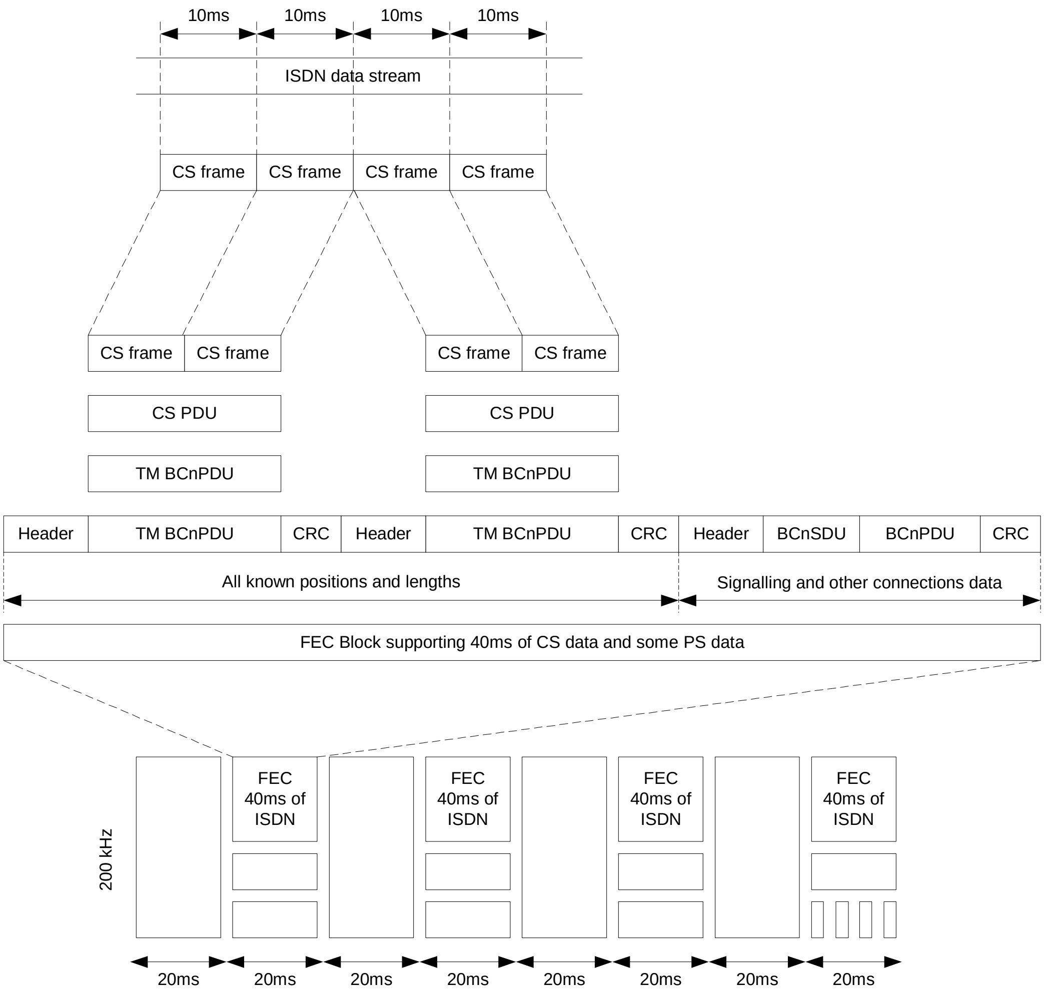

Figure 8.10: Example of multiple ISDN carrying BCtPDUs in a single return burst

8.4.2 Shared Reservation Access

8.4.2.1 Multiplexing of Data and Queue Reporting information in Shared Reservations

For those slots which are defined as Shared Reservation Access, and for which the mobile terminal has an association, the mobile terminal behaviour is determined by the state of the *other-vbr-allowed*, *other-cbr-allowed*, *qlen-based-signalling*, *variable-bit-rate*, *constant-bit-rate*, *other-status-allowed*, *uess-takes-priority* and *other-data-allowed* flags as specified by the RNC in the SlotSharingAVP during connection Establish, Modify or Handover, as well as the (mean and peak rate) QoS information provided in the Type0QoS AVP specified by the RNC during connection establishment or modification.

The UE is responsible for multiplexing traffic from multiple connections into the same return bursts as required by the quality of service parameters for each connection, including honouring the connection class, rate requirements and priority levels.

The UE may utilize slots provided by the RNC for any connection supported by the UE, with the proviso that the rules specified in clause 5.4.1.1 are observed.

8.4.2.2 DTX operation

Support for DTX mode is mandatory for Shared Reservation Access. All connections utilizing Shared Reservation Access mode shall operate with DTX mode active, irrespective of the status of the constant-bit-rate flag. In this mode of operation, if a mobile terminal has no data to send, it shall not transmit in a Shared Reservation Access slot unless required for the maintenance of the connection (controlled by the UpdateRate or DTX parameter depending upon connection type).

For Shared Reservations allocated to connections using variable bit rate connections (those using QRate signalling), the periodicity of transmission of maintenance bursts is defined by the UpdateRate parameter, this taking precedence over the DTX parameter.

For Shared Reservations allocated to connections using QLen signalling, the periodicity of transmission of maintenance bursts will be defined by the DTX interval, which has a default value of 10 seconds, and may be overridden by the RNC using an optional parameter in the Shared Reservation Access AVP, with the requirement for DTX being able to be disabled completely by the RNC if required. Maintenance bursts shall include an AVPList SDU containing a ReceivedSignalQuality AVP.

For connections of type constant-bit-rate the UE shall transmit in at least one DTX burst per second, containing a BCtAVPList with a ReceivedSignalQuality AVP.

8.4.3 Controlled Random Access

8.4.3.1 General Principles of operation

8.4.3.1.0 Overview

The Controlled Random Access principles of operation are that the mobile terminals may transmit signalling and data bursts in the return direction without requesting access to radio resources.

The Controlled Random Access mode can be used by a UE on any of the following conditions:

- If no Dedicated or Shared Reservations are available within a specific return schedule period.
- If the available Dedicated or Shared Reservation does not satisfy the requirements of all connections supported by the UE.
- If the UE has connections for which it has not been able to send its status in reservation during the previous return schedule period and has no reservation in the current period.

The purpose for which the Controlled Random Access bearers may be used is determined by the RNC by broadcasting control parameters that restrict access to the allocation, either in terms of the type of usage or by the rate at which the resources may be used (using a probabilistic control mechanism).

The rules for operating with the Controlled Random Access allocations are intended to achieve low latency while ensuring a reasonably equal probability of loading on all Controlled Random Access slots associated with the same resource allocation within a return scheduling period.

The Transmit Assembly processes the requests for resources in order of the priority as follows:

1) Common signalling
2) UE Specific Signalling
3) Data Connections in order of RAB Access Priority

For each category of request the process determines which Controlled Random Access resource is suitable for utilization by checking the constraints defined by the AccessPriority level for each Controlled Access resource.

The approach that should be assumed for the operation of the Transmit Assembly process is that this is executed on a per-time-slot basis. At each time-slot, the requests for utilization of the return bearer are compared with the opportunities for transmission that are presented. A Controlled Random Access slot shall only be utilized if there are no other suitable Dedicated or Shared Reservation Access allocations which can be utilized during the current return schedule period.

8.4.3.1.1 Initiation of transmission

The Transmit Assembly process determines whether there is a suitable slot for satisfying the request in this timeslot. If one or more such slots exist in the current timeslot (for instance if multiple return bearers are available each of which supports Controlled Random Access transmission in this timeslot), then the Transmit Assembly process considers each of the slots in a random order, and for each slot determines whether the slot should be used by generating a random number in the range 1..16 and if this value is greater than the value obtained when subtracting the value of the Access Probability field for that Controlled Random Access resource from 16, then the mobile terminal may initiate transmission in the identified slot. This process repeats for each identified slot until either a slot has been selected or all such opportunities have been exhausted.

If no such slot exists in the current timeslot, or the Access Probability criteria fails for any suitable slot in this timeslot, then the Transmit Assembly process terminates until the next slot epoch (80 ms slot boundary), when the process is reinitiated.

8.4.3.1.2 Continuation of transmission

Once the mobile terminal has initiated operation on a Controlled Random Access resource, it may continue to transmit subsequent bursts on the same bearer if required, providing that the connections which require access to the resource satisfy the RAB Access Priority criteria (as provided during the Establish procedure), and that the Access Probability criteria as defined above is satisfied (a new random number shall be generated to determine whether each subsequent slot may be accessed). If the RAB Access Priority criteria is not satisfied, then the mobile terminal shall not transmit in that time-slot, but shall terminate the Transmit Assembly process until the next slot epoch, when the process of initiation of transmission is reinitiated.

8.4.3.2 Multiplexing of Data and Queue Status Reports in Controlled Random Access

The inclusion of queue status and data within a Controlled Random Access burst is limited to those connections that satisfy the Access Priority. The use of the Controlled Random Access is fairly straightforward, on the basis that the priority will be the signalling connection if it has data to send:

```
include QStatusReport for this connection if necessary
fill Data for this connection
if (space-left-in-slot)
include QStatusReport from connections not of type constant-bit-rate if necessary
include Data for other connections not of type constant-bit-rate
endif
```

When multiple connections require access to the return bearer, the mobile terminal shall multiplex the information into the return bursts in the following order:

1) The UE shall prioritize connections without reservation in the current return schedule over all connections with reservations.

2) The UE shall transmit as the first priority UESS signalling connection data.

3) The UE shall start data multiplexing with the Interactive connections with the highest Traffic Handling Priority and end with the Background class connections.

4) The UE shall handle all connections of the same type and Traffic Handling Priority in order of highest to lowest RAB Access Priority.

5) The UE shall treat all connections of the same type and RAB Access Priority equally, serving data from each connection on a round-robin basis.

6) Repeat rule 2-5 for connections with a reservation in the current return schedule period.

8.4.3.3 Untimed operation of Controlled Random Access

The expectation is that most mobile terminals will be operating with timed access, however provision for a limited number of untimed bursts operating with Controlled Random Access is incorporated into the system. Because of the 80 ms slot duration, there is no ambiguity with regard to the slot boundary in which the mobile terminal is attempting to transmit. The mobile terminal initially attempts to operate in primary timing mode and applies a locally calculated self-imposed-delay. If a timing correction is applied by the RNC, then the mobile terminal modifies its self-imposed delay and remains in secondary timing mode until the RNC provided corrections match that calculated for the self-imposed-delay to within a tolerance of 120 µs, when primary timing mode may be reinstated.

The RNC may allow or disallow the use of LDR bearers for untimed access. When the RNC disallows the use of untimed access for LDR bearers, the UEs shall use legacy non-LDR bearers when operating in untimed mode.

8.4.4 Contention slot usage

8.4.4.1 General Principles of operation

Contention slots are used by UEs which have not been allocated any reserved capacity. This allows a UE which has just become active to register on the RNC and also allows registered UEs which have been idle for some time to send Queue Status signalling messages for either UE Specific Signalling connections, Background Class or Interactive class connections.

Two types of contention slot allocation are defined. UEs which have acquired the necessary transmit timing accuracy are able to operate in timed access mode, which allows them to transmit a burst accurately within a single contention slot as they can be guaranteed to respect the slot timing and guard-times. UEs which have not acquired the necessary timing accuracy may need several adjacent contention slots (as calculated by the UE on the basis of *MaxDelayAndDelayRange* AVP) to guarantee that their bursts do not collide with burst transmissions from other UEs in reserved slots.

Transmissions in contention slots may collide with transmissions from other UEs, causing the loss of multiple bursts. After a period greater than the round-trip time, if no response to a contention transmission has been received by the UE, the UE will need to retransmit the information in a further contention slot. To ensure that the system does not become unstable, it is necessary for the UE to delay any retransmissions by a random delay (this delay is termed a back-off interval). The back-off interval is dynamically configurable by the RNC, which adjusts the interval in response to congestion occurring within the contention slots. The Bearer Control Layer receives notice that a PDU segment is a retransmission via the RetryCount parameter in the BCt_DATASTATUS_REQ or BCt_COMSIGSTATUS_REQ message, and this is used to identify the onset of congestion at the RNC.

8.4.4.2 Contention Slot Usage Backoff mechanisms

When a UE decides to transmit some data in a contention slot, it selects a random frame to send it in based on the *RandomisingLevel* value:

$$Selected\ Frame = random(0, FrameRandomiser \times (2^{l\ +\ RandomisingLevel})\ slots$$

The parameter *RandomisingLevel* increments from zero up to *MaxRandomisingLevel*, whenever a collision or loss is detected by the timeout of the status-ack-timer due to failure to receive the *StatusAck*.

The parameters *FrameRandomiser* and *MaxRandomisingLevel* are as specified in the *RandomisingControl* AVP.

The contention-slot back-off mechanism is slightly different at initial registration: no Status SDU shall be sent, so it cannot be randomized using *StatusAck*. Instead, at registration (known because the data comes in on the BCt-COM-SAP), *RandomisingLevel* is set directly from the Connection Layer RetryCount. Then, *SelectedFrame* is initialized normally from *RandomisingLevel* using the above formula.

The *SelectedFrame* counter is decremented on every Return Schedule SDU that contains a contention slot accessible by the Return Schedule Processing entity (including considerations of Untimed Access Mode and return bearer type), by an amount equal to the number of accessible contention slots. The return schedule period and 200 kHz sub-band, pertaining to the Return Schedule SDU causing *SelectedFrame* to reach zero or less, is the one the UE shall burst in. The Return Schedule Processing entity shall uniformly randomize its usage of contention slot, from those specified by all the return schedules of the selected return schedule period.

Thus, take an example where there are 3 contention slots per Return Schedule on return-bearer #0 (on an ongoing basis), 2 contention-slots per RS on return-bearer #1, and a *FrameRandomiser* = 3:

1) the first occasion on which the UE sends in a contention-slot, *RandomisingLevel*=0 so *SelectedFrame* shall be in the range 0 to 6, assume SelectedFrame=2 for example; the UE chooses one of the 3 contention-slots within the first return schedule period it sees. If this collides, no StatusAck is sent, and the StatusAck timer times out causing *RandomisingLevel* to be incremented, then:

2) the second occasion, *RandomisingLevel*=1, and for example *SelectedFrame* is chosen as 3 (in the range 0 to 12). The UE sees RS #0, return-bearer #0, and decrements *SelectedFrame* by 3. Now, *SelectedFrame* = 0, so it transmits on one of the 3 contention-slots on RS #0, return bearer #0. If this collides, so no *StatusAck* is sent, and the *StatusAck* timer times out, then:

3) the third occasion, *RandomisingLevel*=2, and for example *SelectedFrame* is chosen as 7 (in the range 0 to 24). *SelectedFrame* is decremented by 3 for RS #0, bearer #0. Then by 2 for RS #0, bearer #1. Then by 3 for RS #1, bearer #0. Now *SelectedFrame* = -1, so it transmits on one of the two contention-slots on RS #1, return bearer #0.

For contention-slots which occur at the same time on different Return Schedules, it is implementation-dependent whether randomization occurs:

1) By choosing the RS first (via *SelectedFrame*), and then randomizing over accessible contention-slots within the RS.

2) By randomizing between the simultaneous contention-slots first, and then using SelectedFrame to choose the time-period.

In either case, it is mandatory that *SelectedFrame* is decremented in total by the number of useable contention-slots within a return schedule period.

8.4.4.3 Contention Slot Usage in Untimed Access Mode

A special case arises for Mobile Terminals operating in Untimed Access mode (which arises either at registration with no GPS position, or after timing synchronization has been lost, e.g. after blockage has caused *TimingCorrectionUpdateInterval* to be exceeded). Suppose a UE intends to use a 5 ms contention slot; the latest it will be seen by the RNC is if it is at the back edge-of-coverage, which coincides with correct timing (Self-Imposed Delay should be zero). The UE shall allow for having a position anywhere up to the front edge of coverage, where the burst will appear to the RNC up to *BeamDelayRange* earlier.

Thus, if *BeamDelayRange* is 15 ms, the UE requires at least 15 ms of allocated contention-slot time before the contention slot it actually uses. If fewer than 4 consecutive contention slots of 5 ms are in the return schedule, the UE does not have guaranteed space in which to burst, and shall not use the contention slots (as calculated in clause 9.4.17). If there are 6 consecutive contention slots, the UE shall randomize its usage between any of the last 3 contention slots of this group, as shown in Figure 8.11.

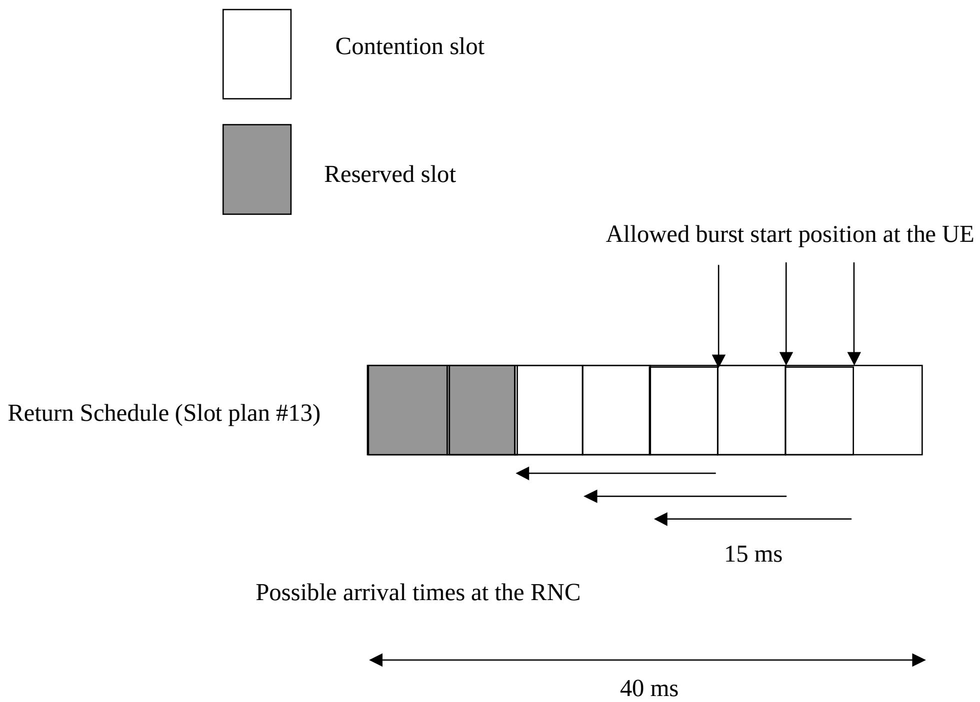

Figure 8.11: Return schedule validity diagram at the UE antenna

If a message is lost due to a collision, the *RandomisingLevel* shall be incremented and hence the retransmission is randomized over a longer period.

8.4.4.4 Queue Status Reporting in contention slots

Connection Layer data is allowed to be transmitted on a contention slot as follows: if Criterion A defines that a contention slot may be used for a Status SDU, then some of the queued data may be piggybacked within the same burst.

When a return schedule is received with contention slots the UE shall use the Criterion A to establish if any active connection needs contention slots for Status SDU signalling. The UE shall aggregate Status SDUs for different connections into the same slot, if more than one Status SDU requires to be transmitted.

If the need for a contention slot is established through using Criterion A, and transmission is required outside of the present sub-band the UE shall make sure there is at least *RetRetuneTime* between transmissions in the two sub-bands.

```
If the return schedule(s) contain at least one contention slot that the UE's timing accuracy permits it to use
then for each return schedule:

    For each connection record, CN:

        If CriterionA (CN) then:

            If SelectedFrame <= 0 then

                Pick a contention slot at random out of any contention slots on the Return Schedule on any
                Forward Bearer that meet the following criteria:

                a) The slots shall be within the same 200 kHz sub-band. Or at least the RetRetuneTime away
                from any reserved slots.

                b) Statevec_valid and beam_delay_valid must be OK (see clause 9.4). Then, if SYNC=NO,
                which contention slots are allowed to be used depends on how many adjacent contention slots
                exist, otherwise return channel timing synchronisation has been achieved, and any contention-
                slot is acceptable

                If successful in finding a slot to use then

                    Include the slot in the transmission schedule.

                end if

            else

                # If CN.SelectedFrame>0 then the next contention slots for

                # this connection is being randomised and do not send in this frame.

                If there are any contention slots that could have been used in this return schedule then

                    Let CN.SelectedFrame = CN.SelectedFrame - number of contention slots in return schedule

                # this only gets decremented once per return schedule

                end if

            end if

        end if

    end loop "for each connection record"

end if

end Return Schedule processing
```

There is a special case where data replaces a Status SDU in a contention slot. This occurs when Criterion A requires a contention-slot to be used, but then Criterion B determines that the data will fit completely within the slot emptying the connection queue and hence the data is sent instead of the Status SDU. If space remains within the slot, a zero queue Status SDU may be sent, but otherwise there is then no *StatusAck* timer to indicate failure and initiate back-off, so the RetryCount parameter coming down from the Connection Layer is used. If this is non-zero, the Control layer assumes that this could have been contention failure, and thereafter forces a Status SDU to be sent, so that it can handle the contention-channel back-off correctly by increasing *RandomisingLevel*.

8.4.4.5 Transmit_Schedule Process (Informational)

This process identifies useable slots, from the received return schedules, and calls the *Create_Slot* process to fill the slots with data or Status information. This clause is considered informational, and is mainly applicable to legacy UEs that operate only with Status SDUs.

```
Transmit Schedule Processing

At a time, RetRetuneTime, before a slot is listed in the transmit schedule:

    If necessary, retune the MHU associated with the Translated Bearer Connection ID for the slot to be used.

At a sufficient time before required by the transmit schedule, the byte sequence is constructed. Each
particular burst is associated with a connection, CN (either the connection that the slot was reserved for or, in
the case of a contention slot, the connection that satisfied Criterion A, or a connection that was able to use
spare capacity on the burst, if other-data-allowed):

    If slot to be used is a reserved slot or (slot to be used is a contention slot and Criterion A (CN)) then

        # Check that the contention slot is still required using Criterion A

        Create_Slot (Translated Bearer Connection ID, Reserved, SlotDuration)

        Transmit the data at the scheduled time.

        Record the scheduled time of transmission in variable TLastTx

    end if

    If CN.ControlQ > 0 then

        Let CN.reserved-slot-timer=TransmitTime +

            max((CN.RNCTHeadDelivery-TransmitTime-0.5 × rtt) × BC.ResWaitMultiplier,

                    CN.MinResWait × BC.ResWaitMultiplier)

            where TransmitTime is the time of the start of transmission of the burst just sent.

    end if

    Remove this slot from the transmit schedule.

end transmit schedule processing

If there is more data, the UE expects at least one more reserved slot, and starts the reserved-slot-timer by
when it would expect to see a reservation.
```

8.4.4.6 Create_slot Process

This process takes the final decision, on what data a particular slot shall contain. This process is called from the Transmit schedule process, for each slot used by the UE in the current return schedule. For clarity the process is divided into two sections. The first section updates the UE and the local RNC queue lengths, and calculates the expected delivery time at the RNC of the burst contents.

If the slot contains any Status SDUs these shall reflect the status of the UE queue status after the current data has been sent.

Section 1.

Procedure Create_Slot (Translated Bearer Connection ID, ReservedSlotFlag, SlotDuration):

TBCnID can be NULL if the connection intended for the slot is the Common Signalling Connection.

ReservedSlotFlag depends on whether the slot was reserved or contention; stored with the transmit schedule

Let CN = the connection record for this Translated Bearer Connection ID

For all non-null tBCnID:

Criterion B for this connection shall be called with the parameters:

CriterionB(BC, space-left-in-slot - Bearer-Control-overhead)

Define VolData as the volume of data sent including, bearer control and connection overhead, excluding SDUs

Let CN.RNCControlQ = CN.RNCControlQ - VolData

Let CN.RNCTHeadDelivery = CN.RNCTHeadDelivery + VolData / CN.RNCDeliverRate

(CN. ControlQ,THeadDelivery,TTailDelivery and Unsegmentable will all be updated with

from the Bearer Connection via the BCTx_DATASTATUS_req signal)

Continued in Section 2.

Section 2 of the Create_Slot process describes the procedure for prioritizing the information flow into the slot.

Packing of Status SDUs and data into a slot shall ensure efficient use is made of the BCtPDU formats specified in ETSI TS 102 744-3-1 [8]. This implies for example that if both a *ReferenceLevelAcknowledge* and a *ReceivedSignalQuality* AVP are to be sent, they should be encapsulated in a single *status-avp-list* with a Status SDU, rather than all separate with the overheads this implies, if this saves overheads in total. However, attachment of the *status-avp-list* should not prevent a Status SDU being sent, if the Status SDU fits into the available space without the *status-avp-list*, but does not fit if it is included.

Section 2:

Data and/or Status SDUs shall fill the slot ordered from the beginning of the slot in order of priority

The Create_slot process shall not offer capacity to a connection, unless the amount of capacity offered is equal to or exceeds both MinOfferedSize (as set by the SlotSizeControl AVP) and the Unsegmentable value for the Connection (if set at a non-zero value)

If a Status SDU is called for an interactive or background connection, in a slot reserved for the specified connection and ControlQ=0, the UE shall fill a Status SDU reporting an empty queue for that connection.

In any other case, wherever the list of priorities specifies that a Status SDU shall be used if necessary

If the result of CriterionB as previously calculated for this connection returned TRUE, a Status SDU for that connection shall be inserted, otherwise nothing. In the special case where Criterion B returns FALSE because the data for that connection would fit in the slot, but subsequently that data is pre-empted either by status from other connections or because other-data-allowed is FALSE, no special action to allow that data into the slot shall be taken.

Wherever the priority list specifies "fill…..from connections of……", this step shall loop through all open connections with the appropriate class

end procedure Create_slot

8.5 Return Link Adaptation

8.5.0 Overview

The link adaptation algorithm, in general is responsible for keeping the Packet Error Rate (PER) of the forward and return link at a level appropriate to maintain the QoS of the connection. This is accomplished by tracking long-term channel variations and adjusting the coding rate of the channel accordingly while discrete events and short-term fading are covered by the fading margin in the link budgets.

8.5.1 General Principles of Operation

8.5.1.0 Overview

Each bearer type within the system supports a range of sub-types which utilize different coding rates to provide varying protection against noise, fading and interference. The particular subtype to be used in the return direction is determined by the Return Link Adaptation algorithms.

8.5.1.1 Basic Operation Principle

Return link adaptation at the UE side is based on three parameters:

- Reference Level (RL);
- Back Off mode; and
- Back Off.

These are signalled to the mobile terminal from the RNC using a combination of the *ReturnLinkReferenceLevel* AVP, the *InitialReferenceLevelAndMaxCodeRate* AVP, the *ReturnLinkReferenceLevelSet* AVP and/or *InitialReferenceLevelSet* AVP.

The Reference Level (RL) is used to associate the maximum EIRP of the UE on the return with a specific code rate for each bearer type. The RL is defined as 6-bit integer, which is a relative index to code rates in steps of 0,5 dB. By using the bearer tables shown in Annex C of ETSI TS 102 744-2-1 [6], the RL points to a set of bearer subtypes on each of the return bearer types. The reference level signalled in the *InitialReferenceLevelParam*, *InitialReferenceLevelSet* or *InitialReferenceLevelAndMaxCodeRate* AVPs shall be used by the UE when transmitting on a frequency outside the previously used 200 kHz sub-band.

The link adaptation can be used in three main modes. The mode is signalled by the Back Off mode (BOmode) parameter. Back Off (BO) is used differently, depending on which of the three modes is in use:

BOmode 0: The Back Off value is used to control the EIRP in steps of 1 dB, the coding rate remains fixed and is signalled by RL.

BOmode 1: The Back Off value is used to signal an allowed window in which the mobile terminal can trade EIRP for coding rate with a 0,5 dB step size for Backoff.

BOmode 2: The Back Off value is used to signal an allowed window in which the mobile terminal can trade EIRP for coding rate with a 1 dB step size for Backoff.

A *ReturnLinkReferenceLevelSet* or *InitialReferenceLevelSet* AVP additionally contains 10 RL offset values to allow individual RLs to be assigned per bearer type. The bearer-set field of the *ReturnLinkReferenceLevelSet* or *InitialReferenceLevelSet* AVP is used to identify which 10 bearers the offsets refer to. This AVP is relevant to Extension Class UEs to provide a more accurate mapping between EIRP and bearer sub-type performance to compensate for the different fading environments experienced by these mobile terminals.

The *reference-level* field of a *ReturnLinkReferenceLevelSet* AVP is set to the lowest RL calculated by the RNC of the bearer types usable by the mobile terminal within the bearer set. The bearer type or types associated with the lowest RL shall then have their associated *reference-offset* fields set to 0. Remaining *reference-offset* fields shall be assigned a value between 0,5 dB and 15,5 dB at 0,5 dB intervals, such that the addition of the *reference-offset* to the *reference-level* provides the required RLs for the associated bearers.

Table 8.5 identifies the return bearers associated with each *reference-offset* field of the *ReturnLinkReferenceLevelSet* or *InitialReferenceLevelSet* AVP. Whether or not the Distributed Unique Word bearer type is being referenced is derived from the UE Class (see ETSI TS 102 744-2-1 [6]).

The reference-offsets provided to a UE in a *ReturnLinkReferenceLevelSet* AVP shall remain valid until another *ReturnLinkReferenceLevelSet* AVP has been received. On receiving a *ReturnLinkReferenceLevel* AVP, the UE shall continue to apply the offsets from the last *ReturnLinkReferenceLevelSet* AVP received, i.e. add the offsets as applicable to the reference-level received in the *ReturnLinkReferenceLevel* AVP.

Typically there are only one or two bearer types in use within a regional beam. Hence the Extension Class UEs shall also be able to receive the more compact *InitialReferenceLevelAndMaxCodeRate* AVP which contains RLs and Maximum Return Code Rates for any one or two bearers.

Table 8.5: Reference Level Offset field precedence

Offset field	***bearer-set* 0**	***bearer-set* 1**	***bearer-set* 2**	***bearer-set* 3**
0x0	R5T1X-1B	R5T1X-1B	R80T0.5Q-1B	reserved
0x1	R5T2Q-1B	R5T2Q-1B	R80T1Q-1B	reserved
0x2	R5T2X-1B	R5T2X-1B	FR80T2.5X4-5B	reserved
0x3	R20T0.5Q-1B	R5T4.5Q-1B	FR80T5X4-9B	reserved
0x4	R20T1Q-1B	R5T4.5X-2B	FR80T2.5X16-5B	reserved
0x5	R20T1X-1B	R20T1X-1B	FR80T5X16-9B	reserved
0x6	R20T2Q-1B	R20T2Q-1B	FR80T2.5X32-6B	reserved
0x7	R20T2X-1B	R20T2X-1B	FR80T5X32-11B	reserved
0x8	R20T4.5Q-1B	R20T4.5Q-1B	FR80T2.5X64-7B	reserved
0x9	R20T4.5X-2B	R20T4.5X-1B	FR80T5X64-13B	reserved

8.5.1.2 Bearer Table

8.5.1.2.1 Bearer Table Usage

The Return Link Adaptation is based upon the use of a return bearer table (see ETSI TS 102 744-2-1 [6], Annex C). The table interrelates the required C/No levels for different bearer subtypes. A default return bearer table, equal to the one in ETSI TS 102 744-2-1 [6], shall be stored in the UE. Any changes to the table, will be signalled by the RNC using the *BearerTables* SDU. The *BearerTables* SDU can also be used to disable the use of individual subtypes.

Figure 8.12 illustrates the use of the Reference Level (RL) and Back Off in the return bearer table.

Sub type	**R5T1X**								L3	L2		L1		R		H1
Octets									19	21		24		28		31
Avg Kbit/sec									30,4	33,6		38,4		44,8		49,6
Sub type	**R5T2Q**				L8		L7		L6	L5		L4		L3		L2
Octets					19		24		29	34		40		44		48
Avg Kbit/sec					30,4		38,4		46,4	54,4		64,0		70,4		76,8
Sub type	**R5T2X**												L3	L2		L1
Octets													44	46		54
Avg Kbit/sec													70,4	73,6		86,4
Sub type	**R5T45Q**										L8	L7		L6	L5	
Octets											51	57		68	78	
Avg Kbit/sec											81,6	91,2		108,8	124,8	
Sub type	**R5T45X**															
Octets																
Avg Kbit/sec																
Inc. implementation loss (This will be the actual value measured by the RAN).	**C/No**	48,0	48,5	49,0	49,5	50,0	50,5	51,0	51,5	52,0	52,5	53,0	53,5	54,0	54,5	55,0
Control Index	**6 bit value**	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37

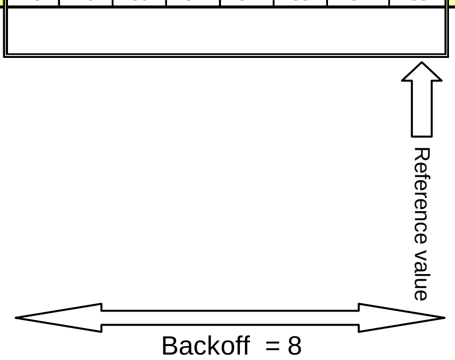

Figure 8.12: Illustration of Reference Level (RL) and Back Off (BO), Mode = 1

By using the bearer tables along with the Reference Level (RL) and the Back Off value, the link adaptation can be used across different bearer types. Figure 8.12 shows an example where RL = 35 and BO = 8. These values allow the UE to use either L8, L7, L6 or L5 if the Return Schedule allocates an R5T4.5Q bearer to the UE. If the UE were allocated a R5T2X bearer, then the allowed subtypes would be L2 and L3.

If the EIRP/code-rate trade-off is not allowed (either in BOmode = 0; or in BOmode = 1 or 2 where the queue-size is greater than the allocation), and the RL points to an empty entry in the table, then the code-rate selected shall be the highest below that specified. In the latter example, this would be L2.

The EIRP allowed to be transmitted by the UE for each of these subtypes is then determined by truncating the EIRP on a 1 dB step size grid relative to the RL. The rounding shall always be upwards.

For the example with RL = 35, BO = 8, Mode =1, the EIRP for each bearer subtype would be as shown in Table 8.6.

Table 8.6: Example where RL = 35 and BO = 8

Bearer Type and Subtype	dB below Reference Level	EIRP (dB below nominal)
R5T4.5Q-1B L5	0,0	0,0
R5T4.5Q-1B L6	1,0	1,0
R5T4.5Q-1B L7	2,0	2,0
R5T4.5Q-1B L8	2,5	2,0
R5T2X-1B L2	0,5	0,0
R5T2X-1B L3	1,0	1,0

In the case where the RL is above the top code-rate of the Bearer Table, then the EIRP shall be reduced proportionately. This is done in line with the difference between the RL and the Control Index position of the code-rate in the Bearer Table.

If the RL is below the bottom code-rate of the Bearer Table, then the EIRP shall not be backed-off and the UE shall transmit with the bottom code-rate.

The Back-off to be applied at the transmitter is quantized in units of 1 dB (as specified in ETSI TS 102 744-2-2 [7]) remaining above the point required to close the link margin, and may additionally be limited by the maximum EIRP back-off for the UE Class in the UE requirement spec (6 dB or 10 dB). For example, a back-off of 3 reference-levels means that the EIRP shall be backed off by 1 dB (rather than 1,5 dB). A back-off of 4 reference-levels means that the EIRP shall be backed off by 2 dB. A back-off of 15 reference-levels for a class 3 UE limited to 6 dB back-off shall mean that the EIRP is to be backed-off by 6 dB.

8.5.1.2.2 Extensions to Bearer Table Usage for mobile UE classes

Mobile terminals which may be fitted to moving vehicles (UE Class greater than 3) shall use the same general behaviour regarding bearer tables as described in the previous clause. However a couple of modifications are required to accommodate the different channel environments experienced by these mobile terminals. While Land Portable (Class 1-3) UEs share a single bearer table for each direction and only have a single link margin for each UE Class, all other mobile terminal UE classes require link margins that are dependent upon terminal class, bearer type and elevation angle.

For these mobile terminal classes, a facility is provided for providing updates to the tables stored in the UEs. During registration, the UE transmits the *version* number of the Bearer Tables it has stored in the RegisterComplete message. The RNC may then transmit updates to the Bearer Tables, providing a new version number using the *BearerTableUpdate* SDUs to the specific UE. The UE shall store the updated tables in non-volatile memory and report the new version number during future registration.

The mobile terminal shall periodically report its current position to the RNC. The mobile terminal shall be capable of receiving a new set of RLs and Initial RLs at any time during operation within the *InitialReferenceLevelSet* and *ReturnLinkReferenceLevelSet* AVPs, and shall acknowledge receipt of the *ReturnLinkReferenceLevelSet* or *InitialReferenceLevelSet* AVP.

8.5.1.2.3 Maximum Code Rate Limitations

The maximum code rates to be utilized by a UE are transmitted using the *MaxReturnCodeRate* AVP. Upon receipt of the *MaxReturnCodeRate* AVP the UE shall repopulate the Bearer Table so as to remove the effects of any previously received MaxReturnCodeRate AVPs and then mark as unusable any subtypes higher than the maximum coderates for each bearer type signalled by the new *MaxReturnCodeRate* AVP.

8.5.2 Dedicated Reservation and Contention Access Modes

8.5.2.1 Initial Contention Mode Access

The Initial Reference Level (RLinitial) is a UE Class dependent parameter that shall be stored in the UE and used for determining the appropriate transmit backoff level for operation with return bearers. The backoff level is determined from the difference between the value of Initial Reference Level and the specific value required for the selected bearer type and code-rate.

Initial random access (untimed or timed) on Contention Slots shall use the code-rate defined in ETSI TS 102 744-2-1 [6], or as defined by InitialRandomAccessBurst AVP.

For the initial contention mode transmissions the UE shall use the stored (UE-class-specific) Default Initial Reference Level value to derive the transmit backoff for access to the return bearers, unless overridden by a broadcast InitialReferenceLevelParam AVP containing a UE-class specific return link reference level to be used with this Primary Shared Access Bearer (PSAB).

If there is uncertainty within the UE with regard to the beam type in which it is operating and the InitialReferenceLevelParam AVP is not received, then the initial random access (untimed or timed) may be undertaken with maximum (nominal) UE EIRP, except for the Class 1, 6, 8 and 10 UEs, where it shall be backed off by 5 dB.

Upon receipt of a Register Ack burst, the UE shall update the RLinitial value with that provided by the RNC, and shall use this new value for subsequent contention and reserved bursts to derive a corrected value for the transmit backoff.

8.5.2.2 Code rate selection in transmission schedule

The code rate selection is dependent on the state of the link adaptation algorithm. The link adaptation algorithm will supply the code rates, which are available for the particular bearer. The link adaptation will also supply information on how much the UE can back off the transmit power and in what situations it is allowable to do so.

The code rate selection is not normally a function of the queue size of the connection the reserved slots are intended for. In BOmode #0, the UE code rate and HPA back-off are fully defined by the RNC commands. In BOmode #1 and #2, if the queue size is greater than the slot-length, code-rate and back-off are still fully defined.

However, in BOmode #1 and #2, if the queue size is less than slot-length, EIRP will normally be traded off by the UE for code-rate to fill the slot. However, signalling transfer always takes priority. When connection specific signalling is ready for transmission, additional signalling octets may require a higher code-rate to be used and hence change the UE transmit power back-off; this may happen as near to the transmission time as practical. An example of this, is when a return schedule for a voice connection is received, the code rate selection might have one value, but when the time comes for transmission, a *ReceivedSignalQuality* AVP needs to be transmitted, and hence the code-rate selection would include this.

8.5.3 Shared Reservation and Controlled Random Access Mode

8.5.3.0 General

When initiating transmission associated with a Shared Reservation and Controlled Random Access Mode (either for the first frame or after a period of interruption in transmission) with the R80T0.5Q and R80T1Q bearers, the UE shall, when required to do so as specified by the RNC in the ReturnBearerTypeParam AVP, transmit an initial acquisition sequence (CW preamble) as defined in ETSI TS 102 744-2-1 [6].

Once the Register Ack has been received and the UE-specific Initial Reference Level has been determined, the transmit Backoff for operation with the R80T0.5Q and R80T1Q bearers, is determined by the Return Schedule Processing entity for each slot handled by the Transmit Assembly process in the following clause.

8.5.3.1 Shared Reservation Access

When allocating resources for operation with Shared Reservation Access mode, the RNC specifies the PowerLevel in dBs relative to the ControlIndex value for the specific return bearer type and code rate that is being allocated. The PowerLevel value is independently specified towards each mobile terminal operating with the Shared Reservation Access. The value of PowerLevel signalled in the SRA overrides the Backoff value in any previously signalled ReturnLinkReferenceLevelParam AVP

The UE shall determine the appropriate transmit power level relative to its nominal maximum power level (transmit backoff value) as follows:

UETransmitBackoff ::=

UENominalPowerLevel(UEReferenceLevel) -

(MinimumBearerPowerLevel(UEClass, BearerType, CodeRate) + RelativePowerLevel)

UENominalPowerLevel represents a function that translates the UEReferenceLevel to an equivalent Nominal UE Power Level (in dB).

MinimumBearerPowerLevel represents a function that translates the UEClass, BearerType and CodeRate to a Minimum Required Power Level (in dB), using the information in the Bearer Tables provided in Annex C of ETSI TS 102 744-2-1 [6].

If the UE Reference Level is modified through link adaptation, or the RNC elects to specify a different PowerLevel, then the UE shall modify the RF power level at the next available slot boundary.

8.5.3.2 Controlled Random Access Return Link Adaptation

For the initial contention mode transmissions the UE shall use the stored (UE-class-specific) Default Initial Reference Level value to derive the transmit backoff for access to the return bearers, unless overridden by a broadcast InitialReferenceLevelParam AVP containing a UE-class specific return link reference level to be used with this Primary Shared Access Bearer (PSAB).

Once the RegisterAck has been received, the UE shall update the Initial Reference Level to be used to derive the backoff level for use on Controlled Random Access and Shared Reservation Access bursts.

If *min-power* and *max-power* values are included in the Controlled Random Access AVP, these are used by the UE to define the maximum and minimum backoff respectively from the Reference Level which should be used for this physical bearer at the code rate specified in the Controlled Random Access AVP. If these values are specified by the RNC, then the UE shall select a random backoff value within the specified range for operation during transmission. A new random Backoff value shall be selected each time an initial transmission on the Controlled Random Access bearers is undertaken, and this value shall be maintained for any continuation transmissions on the same Controlled Random Access Bearer.

The Backoff Value that is selected shall be as follows:

UETransmitBackoff ::=

UENominalPowerLevel (RLinitial) -

(MinimumBearerPowerLevel(UEClass, BearerType, CodeRate) +

MinPowerLevel+Rand(MaxPowerLevel-MinPowerLevel)

In this expression, MinPowerLevel and MaxPowerLevel are the values specified in min-power and max-power within the Controlled Random Access AVP, and MinimumBearerPowerLevel represents a function that translates the UEClass, BearerType and CodeRate to a Minimum Required Power Level (in dB), using the information in the Bearer Tables provided in Annex C of ETSI TS 102 744-2-1 [6].

8.5.4 Dedicated Return Bearers (High Data Rate Operation)

When operating with Dedicated HDR Return Bearers, the Return Schedule transmitted to this specific UE shall define the Bearer Type that is to be utilized. All FEC blocks within each frame shall be modulated with the same modulation and code rate. Link adaptation operates as for normal Dedicated Return Bearer Allocations, however if there is a requirement for modification of the maximum power at which the UE shall transmit (for instance when operating Backoff Mode = 0) the UE shall only modify the transmit power on a frame boundary, with a maximum of 1 dB increase or decrease between any two adjacent frames. The UE shall match the coding rate corresponding to the power level change. During the process of link adaptation the UE will be signalled modulation change only and the symbol rate will remain same. For example, imagine a UE operating with FR80T2.5X32. If the link is good the RNC may signal the UE to operate with FR80T2.5X64. The UE in HDR operation shall not perform the power/coderate tradeoff for partially filled bursts mentioned in clause 8.5.2.2.

When initiating transmission associated with a Dedicated Return Bearer for HDR Operation (either for the first frame or after a period of interruption in transmission), the UE shall transmit a short initial acquisition sequence (CW) as defined in ETSI TS 102 744-2-1 [6] prior to initiation of the transmission of any frame acquisition information, and this initial acquisition sequence shall be at the same EIRP as the subsequent frame.

8.6 Forward Link Adaptation

8.6.1 Shared Access Forward Bearers

8.6.1.1 General principles

The forward link adaptation algorithm shall provide means to track long-term channel variations while the fading margin in the link budgets caters for short term fading and discrete events. The forward link is transmitted with a near constant power level. The coding rate of the individual FEC-blocks provides the means to differentiate the forward bearer to the different UE classes and thereby optimizing the air-interface usage.

The forward link adaptation can be divided into three main tasks: Measuring, Reporting and Acting.

8.6.1.2 Measuring Forward Link Quality

The UE shall continuously measure the C/No on the forward link by using the pilot and UW symbols.

The UE shall perform measurement averaged across 128 (default) forward frames (128 × 80 ms = 10,2 sec), using a sliding window algorithm with equal weights. This default value of 128 can be changed from the RNC by using the *SignalQualityMeasurementInterval* AVP.

In order for the averaging not to be done over two bearers with different C/No values, whenever the UE receives a forward frequency retune command, both the averaging and reporting period shall be re-started. The current measurement shall be discarded without being sent to the RNC. Although for simplicity of implementation it is expected that simply triggering on the receipt of the *ChannelNo* AVP will be selected.

8.6.1.3 C/No Reporting

The C/No reporting can be carried out in two distinct ways.

1) Polled by the RNC.

2) Periodic, initiated by the RNC.

The *SignalQualityMeasurementInterval* AVP, is used to initiate the C/No measurement process in the UE.

If a *SignalQualityMeasurementInterval* AVP is received with *reporting-on* true, then the UE shall start measuring the C/No on the forward link and report back to the RNC every time a full measurement interval has passed. Hence the interval signalled in the *SignalQualityMeasurementInterval* AVP, both give the averaging period and reporting period.

If a *SignalQualityMeasurementInterval* AVP is received by the UE with the *reporting-on* false, the UE shall cease sending C/No reports on the return link.

If the UE receives a *SignalQualityMeasurementInterval* AVP with the *reporting-on* false and the UE is not currently doing periodic measurements/reports, the UE shall return a single C/No measurement after having averaged using the period specified in the *SignalQualityMeasurementInterval* AVP.

The signal quality report signalled on the return link using the *ReceivedSignalQuality* AVP.

When using Status SDUs to report Queue Status information, the UE shall transmit the *ReceivedSignalQuality* AVP in a status-avp-list within a Status SDU if the UE needs to send a Status SDU on any ongoing connection. The AVP will be held in the UE until it is given a chance to be transmitted, although no queue should be implemented. When the RNC expects this AVP to be sent, it shall provide the reservation capacity, possibly by giving one slot of reserved capacity for the UE-specific signalling connection. The UE shall interpret a *StatusAck* corresponding to a Status SDU containing a *ReceivedSignalQuality* AVP as an acknowledgement of the *ReceivedSignalQuality* AVP. The UE defines "corresponding to" in the same way as the clearing of the *status-ack-timer*; that is, gated by the criterion If SeqNum in Ack = BC.StatusSeqNum and Tnow ≥ BC.TStatusSDU + MinRTT. A transmission of any further Status SDUs on the same connection shall result in a re-transmission of the *ReceivedSignalQuality* AVP until acknowledged as above. The value sent may be either the original value or the value current at the time of re-transmission (implementation-dependent). The only other AVP that can be sent in a *status-avp-list* is the *ReferenceLevelAcknowledge* AVP, which does not require this special acknowledgement behaviour.

For mobile terminals that are not using Status SDUs to report Queue Status information, the *ReceivedSignalQuality* AVP shall be transmitted in an AVP-list BCtSDU. The information shall be transmitted to the RNC when an opportunity to transmit occurs, for instance when a Shared Reservation Access or Controlled Random Access slot suitable for transfer of this information is made available. In this case there will be no implied acknowledgement of the information - if the information is not received then the RNC will transmit a further request for information using another *SignalQualityMeasurementInterval* AVP, or it will await the expiry of the reporting interval.

8.6.1.4 Code Rate Selection

The first FEC block shall always be coded so that the least capable UE can decode it. The frame Unique Word shall signal the coding level of this block. The selection of this coding rate shall be based on system parameters such as satellite EIRP and satellite intermodulation noise. Generally in the case of regional beams, this would be the lowest coding rate available on the bearer.

The coding rate for the subsequent FEC-blocks depends on the instantaneous C/No observed by the specific UEs using the forward bearer.

If any of the FEC blocks within the 80 ms frame has a coding level different from that of the first FEC block, then this shall be signalled using a *ForwardBearerCodeRate* AVP. This AVP shall be broadcast in specific FEC-blocks of the forward frame. For non-interleaved forward bearers with multiple FEC blocks (F80T4.5X-8B, F80T1X-4B, F80T1Q-4B), the AVP may be broadcast in the FEC Blocks as shown in Figure 8.13.

F80T4.5X-8B: FEC-block 0 and 4

F80T1X-4B: FEC-block 0 and 2

F80T1Q-4B: FEC-block 0 and 2

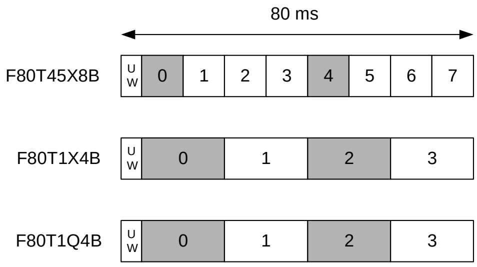

Figure 8.13: Position of ForwardBearerCodeRate AVP

For interleaved forward bearers (FR80T2.5X4/16/32/64 and FR80T5X4/16/32/64), in which the modulation or coding of FEC blocks changes during the frame, this AVP shall always be included in the first FEC block of the frame (it should be noted for the FR80T2.5X4/16-5B and FR80T5X4/16-5B variants the AVP can also be used to signal the modulation of each FEC block).

If no *ForwardBearerCodeRate* AVP is received (including passing the CRC-check) the UE shall assume the same code-rate (and modulation) for subsequent blocks as signalled by the UW.

Some UEs may not be able to decode all FEC blocks. These UEs shall maintain synchronization to the forward frame by using UW and pilot symbols.

8.6.1.5 Sleep Mode

When operating in Sleep Mode, the UE shall stop the measuring and reporting of link quality. When a new *SignalQualityMeasurementInterval* AVP is received, the UE shall re-initiate the link quality measuring/ reporting procedure.

8.6.2 Variable Modulation Index Shared Access Bearers (FR80T2.5X4-5B, FR80T5X4-5B)

8.6.2.1 General principles

The FR80T2.5X4-5B and FR80T5X4-9B Forward Bearers are able to operate with either QPSK (4-QAM) or 16-QAM modulation which may be modified on a per-FEC block basis during each frame. When operating with one of these Forward Bearer types, the first FEC block shall always use QPSK modulation, and subsequent FEC blocks either operating with 4-QAM or 16-QAM modulation.

The signalling of the modulation rate of the subsequent FEC blocks within the forward frame is signalled using the *ForwardBearerCodeRate* AVP (this always being located in the first FEC block of the frame), with the most significant bit being used to signal whether the modulation has changed from 4-QAM to 16-QAM.

There are 5 FEC blocks in each FR80T2.5X4/16-5B frame, and 9 FEC blocks in each FR80T5X4/16-9B frame.

8.6.2.2 Signalling of forward link quality reports

The control mechanisms for generation of link quality reports are used on all forward bearers, although the means for transferring the link quality reports depends upon whether Status SDUs are being used by the UE.

The *ReceivedSignalQuality* AVP shall be transmitted in an AVP-list BCtSDU, when required and when an opportunity to transmit occurs, for instance when a Shared Reservation Access or Controlled Random Access slot suitable for transfer of this information is made available. In this case there will be no implied acknowledgement of the information - if the information is not received then the RNC will transmit a further request for information using another *SignalQualityMeasurementInterval* AVP, or it will await the expiry of the reporting interval.

8.6.3 Dedicated Forward Bearers (FR80T2.5X16/32/64, FR80T5X16/32/64)

When operating with Dedicated Forward Bearers for High Data Rate operation, the forward bearer type is initially selected by the RNC and provided to the mobile terminal as part of the handover process. The reporting mechanism is based upon that for legacy shared access forward bearers.

The HDR capable UE shall also support the ability to receive a change of Forward Bearer type for the dedicated forward bearers using a ChannelNoParam AVP that is broadcast by the RNC within an AVP-List on the forward bearer. If there is a need to signal to the UE a modification to the Forward Bearer type then the information will be transmitted multiple times, on subsequent frames, prior to making the switch to the new bearer type.

The UE shall adhere to the following rules:

Case 1: The ChannelNoParam AVP indicates a modulation change but the symbol rate remains unchanged:

This case is supported when the frequency of operation remains unchanged. In this scenario the UE should choose an appropriate acquisition strategy that can keep the connection active during the modulation change but it is allowed to have a higher PER during the transition period.

EXAMPLE: The current bearer is F80T2.5X32 on channel number 15 000. The ChannelNoParam AVP may indicate the new bearer as F80T2.5X64 on channel no 15 000.

Case 2: The ChannelNoParam AVP indicates a symbol rate change:

In this case the ChannelNoParam is used to signal a symbol rate change to the UE. The AVP may also indicate a modulation change. In this scenario, the UE shall be asked to tune to any supported forward channel frequencies. The UE shall perform warm acquisition to tune to the new forward bearer. The specifications for warm acquisition are as stated in ETSI TS 102 744-2-2 [7], clause 5.2.8. The UE shall terminate any transmissions and wait for a return schedule on the new bearer to commence any transmissions.

EXAMPLE 1: The current bearer is F80T2.5X64 on Channel number 12 000. The ChannelNoParam AVP may indicate the new bearer as F80T4.5X on channel no 12 000.

EXAMPLE 2: The current bearer is F80T5X64 on Channel number 10 000. The channel number AVP may indicate the new bearer as F80T4.5X on channel no 10 000.

8.7 Receiver Processing (Bearer_Rx)

On receiving a Forward FEC Block via the Rx-SAP from the Physical Layer, the Bearer_Rx Process shall split the payload contents of the FEC block into separate BCtPDUs and for each BCtPDUs, the CRC shall be calculated and:

- If the CRC (at FEC block or BCtPDU level) evaluates as "true" (meaning correct), the BCtPDU(s) shall be processed as follows:
  - Broadcast BCtPDUs shall be split into BCt SDUs which shall be processed as follows:
    - Return Schedule BCtSDUs shall be forwarded to the Return Scheduling Processing entity.
    - StatusAckList BCtSDUs shall be searched for any tBCnIDs allocated to connections established for the UE, as notified by the Bearer Control Manager (BCtM) and, if any matching tBCnIDs are found, the associated StatusAck information shall be forwarded to the Queue Status Reporting entity.
    - Specific AVPList BCtSDUs shall be searched for any tBCnIDs allocated to connections established for the UE, as notified by the Bearer Control Manager (BCtM) and, if any matching tBCnIDs are found, the associated AVPList shall be forwarded to the appropriate entity (for instance link adaptation information shall be sent to the Return Link Adaptation entity and Controlled Random Access and Shared Reservation AVPs shall be sent to the Return Schedule Processing entity).
    - Any other BCtSDUs that may be contained in a Broadcast BCtPDU, namely BulletinBoard, AVPList, SpotBeamMap, BearerTables, GPSEphemeris and SystemInfoIndex, shall be forwarded to the System Information Broadcast entity.
  - Common Signalling (ComSig) BCtSDUs shall be forwarded to the Common Signalling entity.

- For Connection Specific BCtPDUs, the BCnID or tBCnID carried in the BCtPDU header shall compared against the BCnID or tBCnIDs allocated to each connections established for the UE, as notified by the Bearer Control Manager (BCtM). If any matching BCnIDs or tBCnIDs are found, the BCtPDU shall be forwarded to the specific connection entity. In addition:
    - if the Connection Specific BCtPDU belongs to a connection which has been flagged for delivery of erroneous PDUs (*DelvErrPDU*), then Bearer Rx shall extract the *TMPayloadPositionParam* from the BCtPDU and shall store the values fec-block-num and start-pos as well as the length (bcnpudu_length) of the (transparent mode) BCnPDU in processed BCtPDU.
- On decoding an AVP List, if the UE encounters an AVP with an undefined AVP type (see note), then it shall skip decoding this AVP and continue to decode the remaining data within the SDU.

NOTE: Typically, an undefined AVP type will be an AVP type not defined in the RI-Version implemented in the UE (see ETSI TS 102 744-3-5 [12], clause 6.1.2.2). The RNC will, where required, i.e. in Broadcast SDUs, place AVPs in order of ascending RI-Versions.

- If a CRC evaluates as "false"; and
    - if Bearer_Rx has been notified by BCtM to forward Connection Specific BCtPDUs belonging to a connection which has been flagged for delivery of erroneous PDUs (*DelvErrPDU*), then Bearer Rx shall process the erroneous BCtPDU and any remaining payload from the FEC block as follows: Bearer Rx shall compare the current FEC Block number against the value fec-block-num obtained from the last *TMPayloadPositionParam;* and
        - if the values are equal, Bearer Rx shall use the value start-pos obtained from the last *TMPayloadPositionParam* as well as the length of the (transparent mode) BCnPDU stored previously (bcnpudu_length), to extract the BCnPDU from the payload of the FEC block. No other data shall be extracted from the remainder of the payload obtained from the FEC block or erroneous BCtPDU. The values fec-block-num and start-pos and bcnpudu_length shall be considered as void until another relevant BCtPDU (with CRC evaluating as "true") has been received and the values fec-block-num, start-pos and bcnpudu_length have been updated (as specified above).
    - If no such connections are flagged, then the decoding of the FEC block payload shall be abandoned and the remainder of the data shall be discarded.

Figure 8.14 illustrates a TMPayloadPosition AVP being used to indicate the position of the following BCnPDU, while Figure 8.15 shows an example scenario of UE behaviour on receiving a TMPositionPayload AVP.

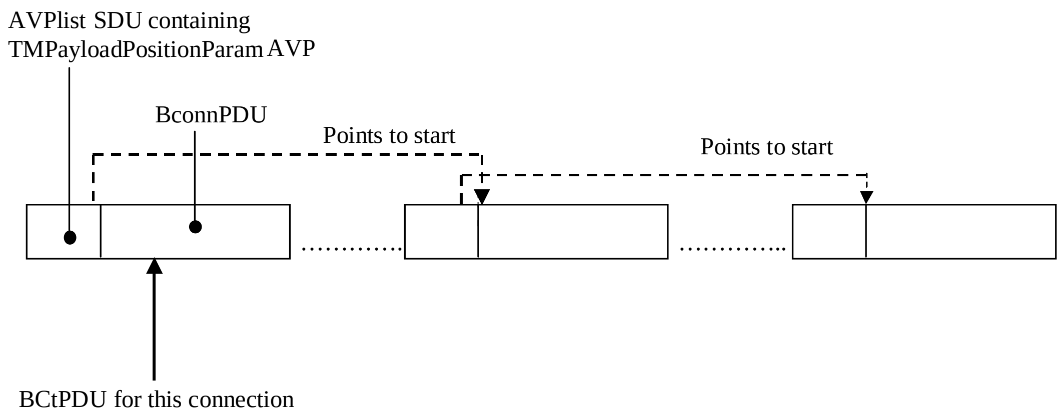

Figure 8.14: TMPayloadPosition AVP used to indicate position of following BCnPDU

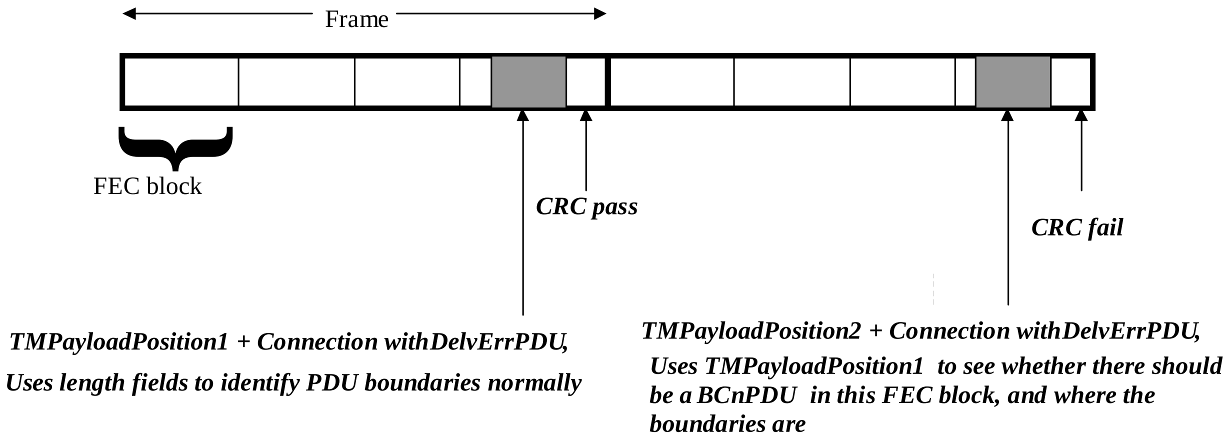

Figure 8.15: Example scenario of UE behaviour on receiving TMPositionPayload AVP

8.8 Transmit Processing (Bearer_Tx)

8.8.0 General

The Bearer Transmit Buffer collects all the BCtPDUs from BCtM, COM_BCt and UE_BCt and sends them to the Physical layer for encoding and transmission.

8.8.1 Dedicated Reservation and Contention Mode Bursts

8.8.1.1 BCtPDU Addressing mechanisms

The addressing mechanisms that are applied are as follows:

1) For common signalling, the address shall be based upon the ComSigAddr field specified by the Bearer Control Manager.

2) For UE Specific signalling and data connections, the addressing shall be based upon tBCnID addressing if a current tBCnID exists for that connection, else the addressing shall be based upon BCnID addressing.

8.8.1.2 CRC generation and Burst Formatting

The FEC block payload shall comprise a sequence of BCtPDUs, each comprising a BCtHeader comprising an address, optional length field, and CRC, the CRC being included immediately after each BCtPDU except for Bearer Types R80T0.5Q-1B and R80T1Q-1B where the CRC is applied across the entire burst and calculated by the Physical Layer.

The Bearer_Tx shall provide the Physical Layer with the correct amount of data (including padding) for each FEC-block payload. The data size for each FEC-block payload could be different depending on the code-rate or burst type used as set by the BCtM in advance. It shall be noted that each FEC-block payload shall contain an integer number of BCtPDUs, except for the R20T4.5X-2B bearer where the two FEC blocks within the return burst are considered as a single entity by the control/connection layer.

8.8.1.3 ISDN Specific Behaviour

The UE shall ensure that for connections used for ISDN services (those flagged by *DelvErrPDU*), the BCnPDU is not preceded by any SDUs within the BCtPDU, and that it shall be the first BCtPDU within the burst. The UE shall ensure that the BCt header is always of type connection-specific, with length field, but with or without timing octet as specified by the standard behaviour. This is so that the position of the start of the BCnPDU can be accurately predicted by the RNC. The UE shall ensure that connections flagged by *DelvErrPDU* shall not use bursts reserved for other connections (or contention slots), although other connections may use reserved bursts for *DelvErrPDU*, if allowed by the Slot Sharing (*osa* and *oda*) flags.

UEs may transmit up to two BCtPDUs carrying ISDN data within a reserved burst. The ISDN carrying BCtPDUs shall appear at the beginning of the burst.

ISDN connections may only be supported in the return direction using Dedicated Reservations - Controlled Random Access and Shared Reservation Access schemes are not applicable for ISDN service operation.

8.8.1.4 Physical Layer Parameters

The Bearer_Tx entity is responsible for specifying the frequency offsets, timing offsets and power levels for each transmitted burst.

The frequency offsets are determined from any local oscillator and Doppler frequency compensation calculations provided by the BCt Manager.

The transmit power levels are determined by any local calibration information, reference level and backoff level provided by the BCtManager and Return Link Adaptation processes in the UE BCt process.

The timing offset levels are determined by the timing reference information provided by the BCtManager. Means for determining the timing offset to apply through the calculation of a Self-Imposed Delay based upon the UE location and Satellite State Vectors are specified in clause 9.4.

8.8.2 Shared Reservation and Controlled Random Access Mode

8.8.2.1 Addressing mechanisms

The addressing mechanisms that are applied are as follows:

1) For common signalling, the address shall be based upon the ComSigAddr field specified by the Bearer Control Manager.

2) For UE Specific signalling and data connections when operating with R80T0.5Q-1B and R80T1Q-1B return bearer types, the first BCtPDU in the return burst block shall always be based upon BCnId addressing. Subsequent BCtPDUs in the same burst shall be based upon tBCnID addressing if a current tBCnID exists for that connection, else the addressing shall be based upon BCnID addressing.

8.8.2.2 CRC generation and Burst Formatting

When operating with R80T0.5Q-1B and R80T1Q-1B return bearer types, a CRC shall be generated for the entire FEC block and included at the end of the FEC block prior to transmission.

When packing an R80T0.5Q-1B or R80T1Q-1B burst, if the burst payload is not filled with Bearer Connection BCtPDUs, the UE shall fill the residue of the frame with a sequence of zero padding prior to submission of the burst to the physical layer.

8.8.2.3 Continuation Burst signalling

When operating in Controlled Random Access or Shared Reservation Access Mode, if the UE intends to transmit a Continuation burst in the subsequent slot, then the *continuation-burst* bit in the *ext-type-and-addr* element of the BCt header shall be set by the UE, else this bit shall be cleared.

8.8.2.4 CW Acquisition sequence generation

Initial bursts in a transmit sequence of bursts on an R80T0.5Q-1B or R80T1Q-1B burst shall be preceded with a Preamble Acquisition sequence (nominally 80 ms in duration) as defined in ETSI TS 102 744-2-1 [6], only when the cw80-acquisition-present flag in the ReturnBearerTypeParam is set to true. Continuation bursts, however, are not preceded by a Preamble Acquisition sequence, but instead commence immediately after the preceding burst without a gap in transmission.

8.8.2.5 Physical Layer Parameters

8.8.2.5.0 General

The Bearer_Tx entity is responsible for specifying the frequency offsets, timing offsets and power levels for each transmitted burst.

8.8.2.5.1 Frequency Offsets

The frequency offsets are determined from any local oscillator and Doppler frequency compensation calculations provided by the BCt Manager. When accessing R80T0.5Q -1Band R80T1Q-1B bearers, these frequency offsets are combined with any RNC specified or random frequency offset provided by the UE BCt Process. For Controlled Random Access bursts, each sequence Initial and Continuation bursts shall have the same Frequency offset, although the Frequency offset applied for subsequent sequence of Initial and Continuation bursts may have a different Frequency offset. For Shared Reservation Access the Frequency offset will be specified by the RNC and constant and fixed for the duration of the Shared Reservation allocation.

8.8.2.5.2 Transmit Power Levels

When transmitting in a Controlled Random Access or Shared Reservation Access slot the UE shall transmit with a backoff determined as specified by the Return Schedule Processing entity for the current slot as defined in clause 5.5.3. The transmitter Backoff level should normally remain constant for any sequence of Initial followed by Continuation burst transmissions on an R80T0.5Q-1B and R80T1Q-1B return bearer. Transmit backoff calculations are stated in clauses 8.5.3.1 and 8.5.3.2. Transmit power levels shall only be adjusted by a UE at a slot boundary.

The UE shall transmit the selected Backoff level as information in the first BCt PDU header of each return burst. The information relating to the forward bearer, including RNC-Id, FbearerNo, BCtId and Spot-beam-ID is transmitted after the mobile terminal has returned to a new forward bearer and before it has received communications from the RNC on the new forward physical bearer. These information elements may also be included if timing is required by the mobile terminal. The mobile terminal cannot describe the backoff when operating in this mode, so it shall use the Initial Reference Level for use with this spot beam type (unless overridden by the RNC using a broadcast or UE-specific signalling mechanism).

8.8.2.5.3 Timing Offsets

The timing offset levels are determined by the timing reference information provided by the BCtManager.

For R80T0.5Q-1B and R80T1Q-1B bearers, the transmit timing for Controlled Random Access bursts may be adjusted by selecting a random time offset within the range specified in the CRA AVP. The selected random timing offset will be then used for the sequence of Initial followed by Continuation bursts on the return bearer. Each time a new transmit sequence is initiated on the Controlled Random Access bearers, a new random time offset will be selected by the UE. The exception being that when a UE performs a CRA access with the timing-required flag set, then the UE shall transmit the burst with timing offset set to zero. For Shared Reservation Access bursts, the timing offset will be specified by the RNC and fixed for the duration of the Shared Reservation allocation.

In Shared Reservation Access mode should the timing offset be modified by the RNC, the UE shall cease to transmit for one slot duration, and shall apply the new timing offset at the initiation of transmission of a burst into the next suitable slot.

9 Timing And Frequency Offset Operations

9.1 GPS Operations

9.1.0 General

The UE is required to obtain geographical position information for correct operation of the system, specifically for spot beam selection, timing offset calculations and to initialize link adaptation mechanisms.

There are situations where acquiring a new GPS position is difficult (for example because the current mobile terminal position is shadowed such that few GPS satellites are visible). In this case, it would be useful to still gain access to the network if the UE has not moved too far from its original position.

The Bearer Control Manager shall keep a copy of the most recently acquired GPS position saved in non-volatile memory, together with its original time-stamp.

The Bearer Control Manager shall keep track of the time, and once per minute the UE shall save the current time to non-volatile memory. If the UE loses GPS lock it shall compare the current time with that of the most recently saved position to determine a loss-of-lock time (this being re-initialized to zero whenever a new position fix is acquired).

When requested by the Adaptation Layer using CBCt_POSITION_REQ primitive on the CBCt-SAP, the Bearer Control shall respond with the CBCt_POSITION_CNF primitive on the CBCt-SAP containing the most recently acquired GPS position (with original timestamp), and loss-of-lock value.

The Adaptation Layer is then able to send this in the UEPositionResponse message to the RNC, where policies will be kept on a beam-by-beam basis of the oldest admissible actual age of the GPS position, combined with the maximum loss-of-acquisition time by the UE since the GPS position was acquired.

9.1.1 GPS Ephemeris information

On the global beam, the GPSEphemeris SDU may be broadcast. This is intended to help the GPS chip onboard the UE in Time-to-First-Fix. The principle is that the Time-to-First-Fix is adversely affected when the GPS chip has been off for some time and is in Cold mode, because it needs to download the full Ephemeris data from the GPS satellites; this could take up to a minute or more, whereas a GPS chip that has current ephemeris data can acquire in Hot mode within 5-10 seconds.

As the satellite network service has a higher data rate than the GPS signal, the present document allows for Ephemeris data, in standard GPS format, to be broadcast on the global beam (or on the regional beam in principle). If the UE GPS chipset allows this, the data available on the GPSEphemeris SDU shall be sent to the GPS chipset to get the chip into HOT acquisition mode.

The GPSEphemeris SDU is sent twice for each GPS PNcode, once with the first half of the Ephemeris data, once with the second half (the FEC block size on the global beam is too small for it to be sent in one SDU). The PNcodes are then sent in a round-robin fashion. The UE shall know when the GPSEphemeris round-robin is complete and it has the full up-to-date data by making use of the System Information Index mechanism. An alternative when the SystemInfoIndex SDU is not present is as follows: when the data for the first section of a GPSEphemeris SDU PNcode that it has already received comes round again, the IODC field in the GPSEphemeris informs the UE of the issue number of the data. If this changes, a full round-robin of the GPSEphemeris shall be collected again; the round-robin period of the GPSEphemeris is not necessarily synchronized with the IODC change-over.

The UE also needs to know GPS time, which can be taken from the UTCDateandTime AVP. Strictly, GPS time differs from UTC time by an integer variable LEAP seconds which changes about once a year. The UTCDateandTime value broadcast by the RNC shall in fact be the GPS time, and hence can be used directly by the UE without correction for the unknown value LEAP.

The round-robin can take longer than the Global beam BulletinBoard round-robin. Therefore, a UE implementing this fast-acquisition service shall transfer from the global beam, at the longer of the BulletinBoard round-robin and two GPSEphemeris round-robins.

However, if after one BulletinBoard round-robin, no GPSEphemeris SDUs at all have been received, the UE shall assume that no GPSEphemeris is available on the satellite network and transfer to the regional beam. Likewise, if the UE has the information available from the GPS chipset that acquisition is currently in HOT mode anyway, then the UE shall not wait for a full set of GPSEphemeris SDUs.

9.2 Doppler Frequency Compensation (Aeronautical UE Classes)

Via the BCt_NAV_SAP interface using the BCt_POSITION_REQ and BCT_VELOCITY_REQ primitives to elicit the BCt_POSITION_CNF and BCT_VELOCITY_CNF responses, the UE shall read the current position and velocity. The Physical Layer Management shall calculate the velocity towards the satellite from the dot-product of the vector between the aero position and the known *SatelliteLocation* and *SatelliteStateVectors* (if known) assuming satellite geostationary orbital height.

$$SatPos(X,Y,Z)_{ECEF} = \left| \begin{array}{l} X = 42164000 \cdot \cos\left(\dfrac{Sat_{Long} \cdot \pi}{180}\right) + \left(X_{StateVector} \cdot 488\right) \\ Y = 42164000 \cdot \sin\left(\dfrac{Sat_{Long} \cdot \pi}{180}\right) + \left(Y_{StateVector} \cdot 488\right) \\ Z = Z_{StateVector} \cdot 488 \end{array} \right.$$

$$\text{Distance} = \sqrt{(Sat_X - UE_X)^2 + (Sat_Y - UE_Y)^2 + (Sat_Z - UE_Z)^2}$$

$$SatVector(X,Y,Z) = (Sat_X - UE_X)/\,Distance,(Sat_Y - UE_Y)/Distance,(Sat_Z - UE_Z)/Distance$$

$$Doppler(X,Y,Z) = 1{,}642\ \text{GHz} \times (SatVector(X).V_X + SatVector(Y).V_Y + SatVector(Z).V_Z)/c$$

The precise frequency in the L-band that is being Doppler-compensated (in principle multiplicatively) need not be considered, because this leads to an offset of at most 34 Hz, and a constant frequency offset across the whole band may be implemented. Although accurate multiplicative frequency correction is not excluded.

The forward link Doppler frequency is also being compensated (see clause 7.1.4); the transmit frequency shall be offset relative to the post-compensation value. In addition, the oscillator frequency error shall also be removed relative to the measured forward bearer frequency.

The full calculation of transmit frequency shall therefore be:

a) Calculate Doppler on forward link, and subtract from nominal Rx frequency

b) Measure residual error to calculate local reference oscillator errors

c) Compensate for local reference oscillator errors as required to meet the requirements in ETSI TS 102 744-2-2 [7]

d) Apply calculated return-link Doppler frequency offset on top of 3)

The accuracy of the result shall be such that the final Tx frequency meets the requirements of ETSI TS 102 744-2-2 [7]. This may imply extra precision on the interface between BCtM and Physical layer to command an accurate frequency value, over and above the commandable frequency granularity of 1,25 kHz, in order to meet the overall frequency stability budget.

9.3 Timing Offset Calculations

9.3.1 Return Channel Timing Control in the RNC

9.3.1.0 General

The RNC controls the delay variations on the feeder links and satellite payload. This is accomplished through knowledge of the satellite state-vectors and location of each of Satellite Access Station (SAS) sites. The RNC measures the timing offset of all incoming bursts, and responds to timing offsets which are larger than a given threshold value, by sending timing corrections to the UEs.

9.3.1.1 Satellite State Vector management

A satellite state vector is a predicted position and velocity of one satellite at a given point in time.

The position and velocity vectors are given in an Earth Centred Earth Fixed (ECEF) coordinate system as X,Y, Z coordinates along with X,Y,Z velocity vectors.

9.3.1.2 State Vector Signalling

The state vectors shall be broadcast on all bearers when primary timing mode is enabled within the RNC.

The frequency of state-vector transmissions is dependent on the satellite orbit inclination.

The maximum satellite velocity at different orbit inclinations and the corresponding update intervals are listed in Table 9.1.

Table 9.1: Satellite state vector updating interval vs. satellite orbit inclination

Satellite Orbit Inclination	Maximum Satellite Velocity ($V_{X,Y,Z}$) [m/s]	Update Interval		
		Seconds	Forward frames (80 ms)	Time To Next Parameter in state vector AVP (see note) (units of 512 frames)
5	268	118	1 475	1
4	215	150	1 875	2
3	161	204	2 550	3
2	108	320	4 000	4
0 to 1	55	738	9 225	9
NOTE: The Time To Next Parameter is twice the needed update rate for precise return channel timing. The double update rate reduces the implications of the 1E-3 PER on the forward link.				

Hence, if for example the maximum state vector velocity ($V_{X,Y,Z}$) is found to be 210 m/s, the satellite inclination is estimated to be between 3 and 4 degrees, hence an update interval of 150 seconds is needed to keep the timing precise. This leads to a "Time To Next" of 2 from Table 9.1.

When primary timing mode is enabled in the RNC, the *SatelliteLocation* and *SatelliteStateVector* AVPs shall be broadcast on the Bulletinboard of the Global beam, before the UE transfers to regional/ narrow spot beam to do registration, which occurs before return-channel timing acquisition is initiated, as mentioned in clause 6.4.1.

9.3.1.3 Satellite State Vector Formatting

The satellite state vector formatting consists of a two main tasks.

1) Normalizing the state vector to the nominal satellite position.

2) Truncating the normalized state vector using a fixed number of bits.

The satellite motion will be contained within a fixed box in the sky which has a maximum size defined by the orbit parameters.

The nominal satellite position is defined as a nominal longitude and orbital height (Latitude = 0 degree). The nominal longitudes of the satellites are broadcast in the global beam System Information (see *SatelliteLocation* AVP). The nominal satellite altitude is 42 164 km (measured from the earth centre). Hence the centre point of the X,Y,Z normalization box would then be uniquely defined by the nominal satellite altitude, nominal longitude, and zero latitude.

The truncated and normalized X, Y and Z state vectors shall be calculated as:

$$X_{Normalised} = \text{integer}\left(\frac{X_{StateVector} - 42\,164\,000 \cdot \cos\left(\frac{Sat_{Long} \cdot \pi}{180}\right)}{488}\right)$$

$$Y_{Normalised} = \text{integer}\left(\frac{Y_{StateVector} - 42\,164\,000 \cdot \sin\left(\frac{Sat_{Long} \cdot \pi}{180}\right)}{488}\right)$$

$$Z_{Normalised} = \text{integer}\left(\frac{Z_{StateVector}}{488}\right)$$

Where:

The ECEF frame is defined as (Compliant to GPS definition, see Figure 9.1):

- Origin coincides with the geo-center.

- The +ve Z-axis is oriented towards Conventional Terrestrial Pole (CTP).
- The +ve X-axis to intersection of "mean" Greenwich Meridian and Equator.
- The +ve Y-axis completes a right-handed Cartesian system and pointing east.

SatLong is the nominal satellite longitude in degrees at 0,1 degrees precision (-180 to +180 degrees) (negative values signifying West and positive values East).

The nominal satellite altitude is 42 164 000 metres.

$(X, Y, Z)_{\text{State Vector}}$ is the instant un-scaled satellite state-vector. Unit: metres.

Integer() returns the nearest signed integer number of the signed argument.

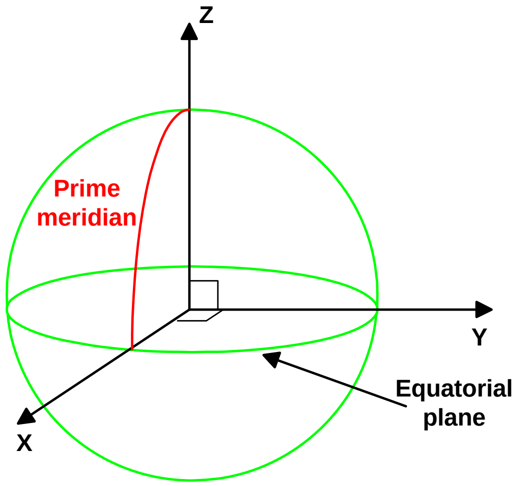

Figure 9.1: ECEF frame definition

9.3.1.4 Estimated Time Of Arrival Determination

The Estimated Time of Arrival (ETA) of an incoming burst at the RNC demodulator is measured relative to the beginning of the forward frame UW containing the return schedule for the slot in question, as shown in Figure 9.2.

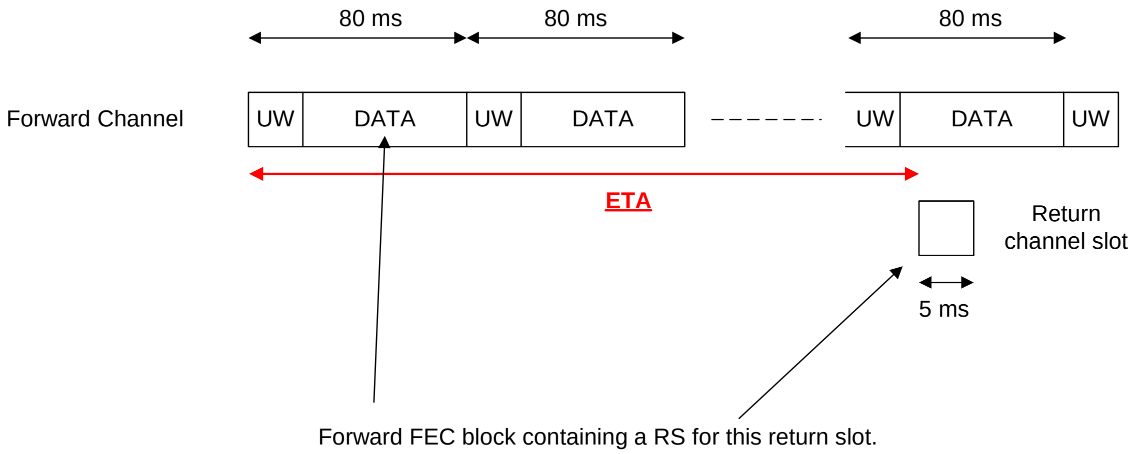

Figure 9.2: Illustration of ETA for a 5 ms return slot

The ETA is defined from the beginning of an UW on the forward link to the beginning of a burst slot on the return link. The ETA is given in microseconds.

The ETA shall be calculated at least every 10 seconds at the RNC.

The RNC ETA calculations shall contain at least the elements listed in the formula below:

$$ETA = UE_{Latency} + 2 \cdot Beam\_Max\_Delay + 2 \cdot Transponder_{Latency} + 2 \cdot RNS2SAT_{Delay} + RNSDelay + SlotNumber \cdot 5000 \quad \text{microseconds}$$

Where:

- UELatency is the round trip latency in the UE: 80 ms.
- Beam_Max_Delay is the beam maximum delay within the used beam: 120 ms to 145 ms.
- TransponderLatency is the full payload oneway latency: 195 µsec.
- RNS2SATDelay is the instant delay between RNC antenna and satellite. This is calculated using the un-truncated satellite state vectors and a known RNC antenna position.
- RNSDdelay is the delay through all the RNC hardware between the modem and antenna. This value has to be measured at the RNC integration stage. It consists of individual contributions in the up and down directions. Notice this delay will be dependent on symbol rate, which in turn can be different for forward and return channel.
- SlotNumber is the slot number in the 80 return channel frame beginning at the ETA point. (See ETSI TS 102 744-2-1 [6] for the return slot number definition).

The ETA is specified at the start of the nominal return slot. The bursts will actually arrive 300 microseconds later (half guard time + CW period).

9.3.1.5 UE Timing Offset Management

The interval between two successive *TimingCorrection* AVPs to a specific UE shall not be less than *RTT* + *UELatency* + *RNCLatency* seconds. The exact value of *RNCLatency* is RNC software implementation dependent.

The RNC shall keep track of the timing offset of all incoming bursts. If a burst is received with timing offset larger than ±120 microseconds (±4 T1 bearer symbols), the RNC shall send a *TimingCorrection* AVP to the UE. The decision on whether or not a timing offset is larger than 120 µs shall be taken on the basis of the raw timing offset measurement, and not on the rounded version described in the *TimingCorrection* AVP definition. The reason for this requirement is to preserve granularity in the decision on whether or not to pull a UE out of the primary method.

If a burst is received at the RNC containing a PDU with the *TimingRequired* bit set, the RNC shall respond on the forward link with a *TimingCorrection* AVP.

The RNC shall calculate the maximum allowable time between UE transmissions before the time uncertainty becomes too high. This parameter shall be based on the weekly satellite inclination as described in clause 9.3.1.2, by using the satellite inclination and Table 9.2.

Table 9.2: TimingCorrectionUpdateInterval AVP parameter

Satellite Inclination	***Max-Interval*** **(minutes)**
5	4
4	5
3	7
2	11
0 to 1	25

The *TimingCorrectionUpdateInterval* AVP shall be broadcast in the Global Beam System Information.

9.3.1.6 Beam Parameters

Each beam on the satellites has a set of timing parameters: Beam_Max_Delay and Beam_Delay_Range. These parameters shall be stored in the RNC. Please see Appendix 2 for the values.

These parameters shall be signalled to the UE via the *MaxDelayAndDelayRange* AVP, when a beam-handover is performed.

9.4 UE Return Channel Timing Operations

9.4.0 General

The UE receives state vectors on the forward link, which it uses to calculate the instantaneous satellite position. The state-vectors are calculated such that they describe an offset (x, y, z) from the nominal satellite position (see clause 9.3.1.3). The state vector AVP also contains an *interval* parameter that informs the UE in how many frames the next satellite state vectors will be broadcast. The state vectors are broadcast exactly twice as often as required for precise timing, thus allowing FEC-block errors to occur without leaving the UE incapable of transmitting.

The nominal satellite positions are broadcast in the Global Beam System Information, using the *SatelliteLocation* AVP. This AVP gives the nominal longitude of the satellite. The nominal altitude and latitude are fixed (42 164 km and 0 degree).

Knowing the distance to the satellite, a UE can calculate a self-imposed delay such that all UEs in a particular beam have the same round trip delay on the L-band link. Each beam will have a maximum round trip delay associated with it, due to the physical location of the spot on the earth. Depending on the SpotBeam-ID this round trip delay will vary. When all UEs have adjusted their timing offsets to precisely achieve the same round trip delay within a beam, the return channel is synchronized.

If the UE cannot establish the geographical position estimate or the satellite state-vectors are invalid, the un-timed random access method shall be used to establish the return channel synchronization.

The Return Channel Timing Control (RCTC) algorithm consists of five separate processes along with three parallel processes. One of the five separate processes defines the entry point for the algorithm, and executes the other four processes depending on the UE synchronization state.

All of the parallel processes shall be executing at any given time.

9.4.1 Variable definitions

Variable definitions for UE return channel timing are shown in Table 9.3.

Table 9.3: UE return channel timing variable definitions

Variable Name	Function
SYNC	This global variable is used to indicate the synchronization state (power-on value NO). NO: Timing synchronization not achieved yet or lost. UEPOS: Timing synchronization achieved using position estimates of UE and satellite. NO_UEPOS: Timing synchronization achieved using un-timed random access and RNC measurements.
Check_Value	Boolean variable used by e.g. Check_SID_Calc to signal the outcome of the SID calculation check. Also used by other processes to signal the outcome of Boolean functions. Values: OK and NOT_OK.
Time_Elap	This variable is used to keep track of the duration of time since last transmission of a burst. The resolution is 1 second and the range shall be 0 to 255 minutes. Power-on value 0.
StateVec_Valid	This variable is used by the parallel process State_Vector_Update to signal if the statevectors are valid. Values: NOT_OK and OK. Power-on value NOT_OK.
SID	This variable holds the main output of the RCTC. It holds the self imposed delay the UE shall use on all burst transmissions. The format is microseconds, and the range shall be from 0 to 80 000.
RNC_SID	This variable contains the most recent update of the SID by the RNC signalled through the TimingCorrection AVP.
StateVec	Variable containing the nominal satellite positions represented as a nominal longitude only. Also contains X,Y and Z coordinates of the satellite relative to the nominal satellite position. (Power on value: any) Values: X: Scale: ± 500 km, 11 bits, resolution: 488 metres. Y: Scale: ± 500 km, 11 bits, resolution: 488 metres. Z: Scale: ± 3 998 km, 14 bits, resolution: 488 metres. SatLong: Scale: ± 180 degrees, 12 bits, resolution: 0,1 degrees.
UE_ECEF_POS	UE position in ECEF coordinates (X,Y and Z). Unit: metres.

Variable Name	Function
Beam_Max_Delay	Maximum delay possible in presently used satellite beam. Unit: Milliseconds between 120 and 145 milliseconds in 5 millisecond steps.
Beam_Delay_Range	This value can be used to determine how many contention slots are needed for un-timed random access. This variable is updated through the Beam_Delay_Range_Update parallel process. The value is a 4 bit integer giving the delay range in 5 ms blocks. Hence a value of 3 means that the delay range is 15 ms. The Beam_Delay_Range is given for an L-band round trip, hence up and down link effects on L-band.
Beam_delay_valid	Flag to show that the values in beam_max_delay and beam_delay_range have been set by receipt of an AVP. Values OK and NOT_OK, power-on value NOT_OK.

When the RNC sends the *SatelliteStateVectors* AVP on the global beam, it shall ensure that the *MaxDelayAndDelayRange* AVP is sent within the same *AVPList* or *BulletinBoard* and prior to the *SatelliteStateVectors* AVP. For all other cases, these AVPs should have been received during the beam Handover and hence Beam_delay_valid should have the value OK.

9.4.2 Entry: (PROCESS)

Entry is the process that is required to be executed before any transmission is initiated on the return link. The process calls the appropriate process depending on the current synchronization state (see Figure 9.3).

Entry shall be executed before each individual burst transmission, but only required once for every Return Schedule (RS). Hence if more than one slot is used by the UE in any Return Schedule, the *Entry* process only needs to be executed once. The purpose is to prevent the UE transmitting in a reserved slot unless the timing has been validated (either by UEPOS_sync or No_UEPos_sync); otherwise, transmission will be inhibited until UEPOS_available or No_UEPOS has validated the timing.

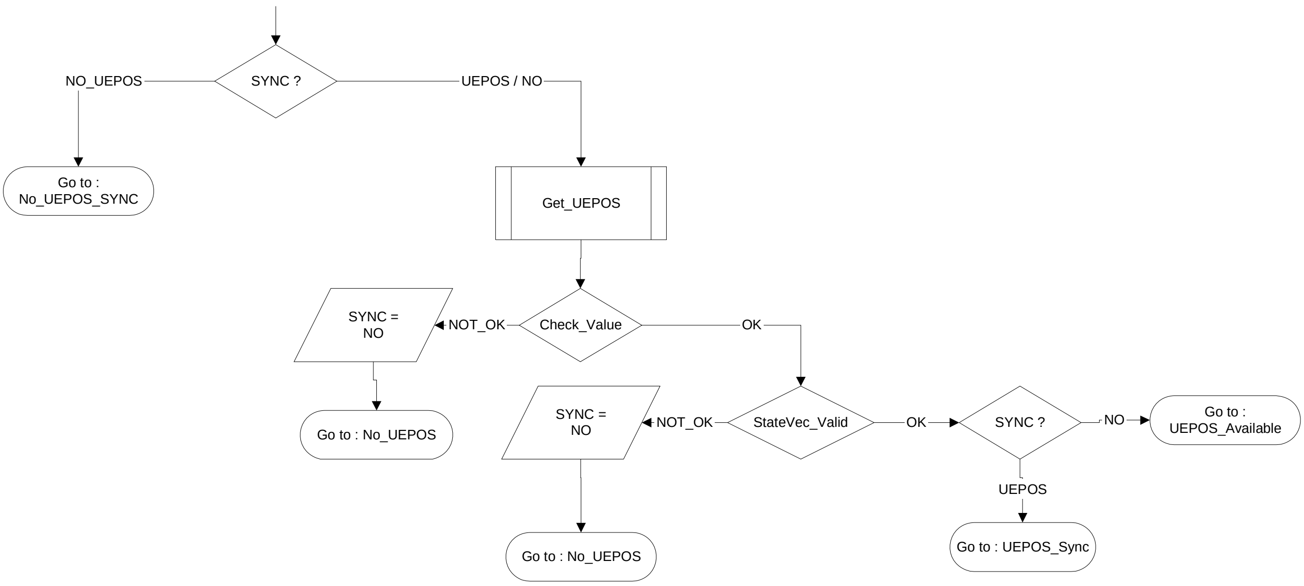

Figure 9.3: ENTRY Process

9.4.3 UEPOS_Sync: (PROCESS)

UEPOS_Sync is called by *Entry* before each transmission if the UE has achieved timing synchronization using satellite position and UE position estimates. The process updates the Self Imposed Delay (SID), checks the calculated value, and uses it for the next transmission if the SID is within a valid range, as shown in Figure 9.4.

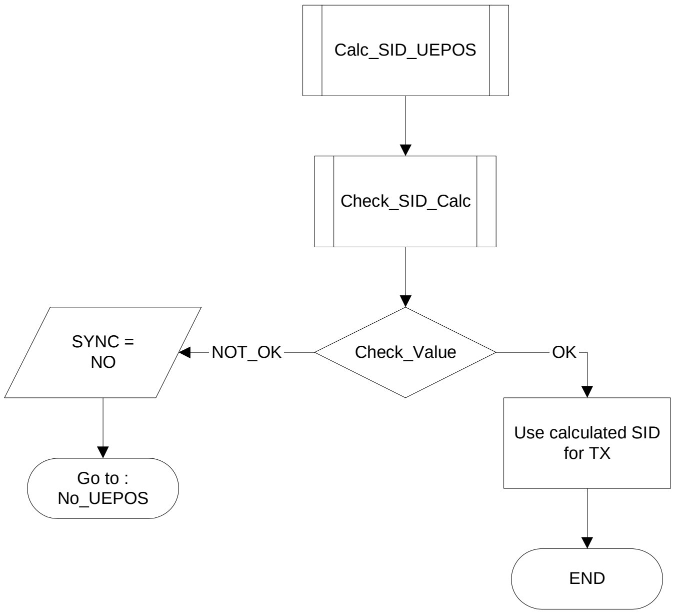

Figure 9.4: UEPOS_Sync Process

9.4.4 NO_UEPOS_Sync: (PROCESS)

NO_UEPOS_Sync is executed by *Entry* before every transmission if the UE has achieved timing synchronization using the un-timed Random Access method. When the un-timed random access method is used the UE relies on the RNC to keep track of its timing error.

The last signalled SID value from the RNC is re-used (which is either as calculated by NO_UEPOS, or zero if this is the initial random access), and the Time_Elap variable is set to zero.

9.4.5 UEPOS_Available: (PROCESS)

The *UEPOS_Available* process is used for achieving timing synchronization using UE position and satellite position. This process (see Figure 9.5) calculates the SID, and checks the value against a valid range. If the value checks out, the process waits for a contention slot to be available. If the Return Schedule containing a contention slot has more than one contention slot, the process will use a random slot within the contention slot group.

The random access burst shall have the *TimingRequired* bit set. This will force the RNC to return a *TimingCorrection* AVP to the UE.

A random access attempt is considered successful, when a *TimingCorrection* AVP is received from the RNC containing a value smaller than ±120 µsec (= 4 T1 symbols). Until it is considered successful, the UE remains in SYNC=NO mode, and can transmit only in Untimed Random Access slots.

In the case of a timed random access being performed with an AL registration PDU, the time out for an RNC response should the AL timeout value set by the CommonSigRetry AVP, or its default of 5 seconds. For all other cases where Status SDUs are used to fill a contention slot, the timer shall be the status-ack-timer.

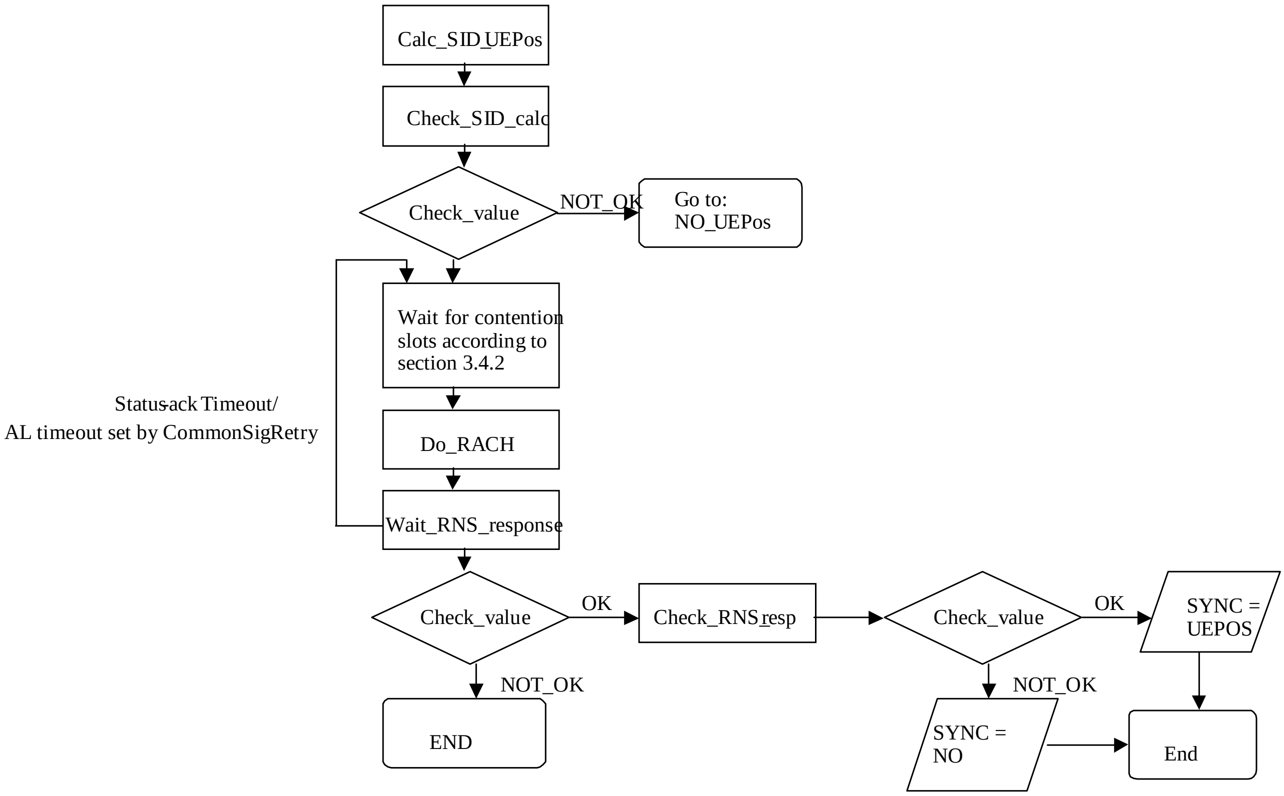

Figure 9.5: UEPOS_Available Process

9.4.6 NO_UEPOS: (PROCESS)

The *NO_UEPOS* process (see Figure 9.6) is used to achieve timing synchronization using an initial un-timed random access burst, and then relying on the RNC to monitor/maintain the timing synchronization throughout the UE communication session. The initial value of SID used shall be zero.

Firstly, the process calculates how many consecutive contention slots are needed before an un-timed random access can be transmitted. Then it uses the contention-slot back-off procedure to randomize its frame usage, and waits until SelectedFrame = 0. The process then waits for enough consecutive contention slots to be available in the received Return Schedules. If there are more than the needed contention slots in a group of contention slots, the process chooses one of the excess contention slots on a random basis. Hence if the UE has calculated that it needs 2 excess slots to do the untimed random access and it receives a return schedule with four contention slots, it shall choose one of the two last slots on a random basis.

The random access burst shall be transmitted with the *TimingRequired* bit set. This will force the RNC to return a timing correction AVP to the UE.

A random access attempt is considered successful, when a *TimingCorrection* AVP is received from the RNC. This sets RNC_SID, which is used to calculate SID.

In the case of an untimed random access being performed with an AL registration PDU, the time out for an RNC response should be the AL timeout value set by the CommonSigRetry AVP, or its default of 5 seconds. For all other cases where Status SDUs are used to fill a contention slot, the timer shall be the status-ack-timer.

If called other than with an AL registration PDU, whilst waiting for the SelectedFrame or RNC response, this routine could be called again in principle. Each connection will only call it with a Status SDU, as connection data is normally barred from contention slots, and the UE Status SDU behaviour will cause these calls only to occur once per connection - these calls can be handled independently and in parallel, as there is only one value of SID and SYNC per UE, and these are independent of connection.

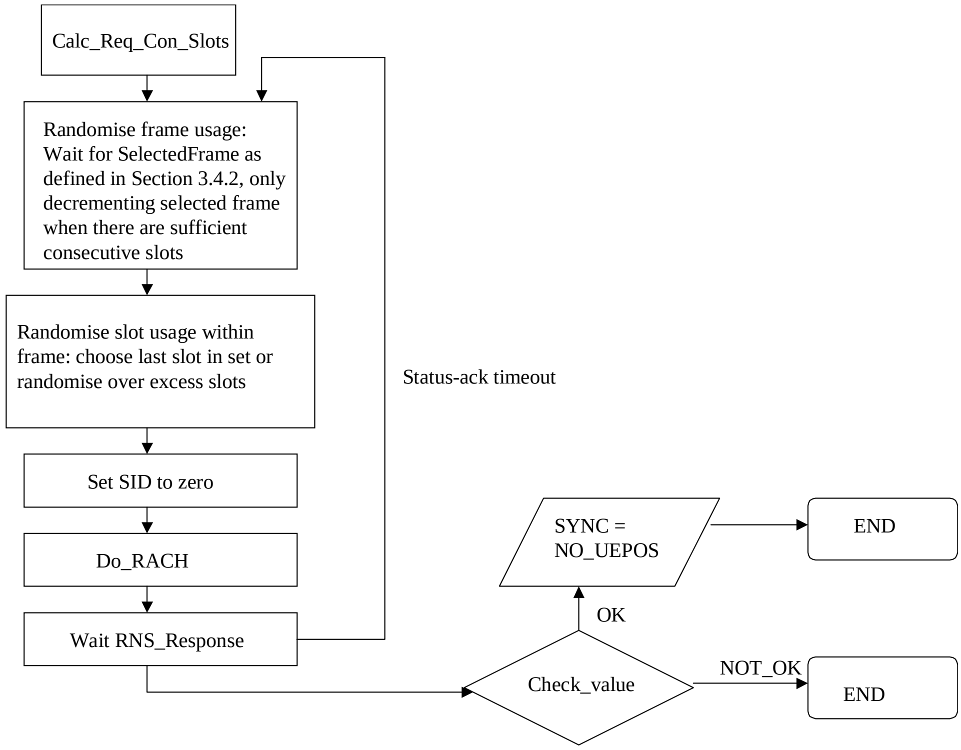

Figure 9.6: NO_UEPOS Process

9.4.7 State_Vector_Update: (PARALLEL PROCESS)

This parallel process keeps the satellite state-vectors updated, by receiving new updates on the forward link periodically.

The process sets the State_Vector_Valid variable, which allows the algorithm to evaluate if the state vectors are valid for use.

This process also extracts the nominal satellite position from the global beam System Information and includes it into the StateVec variable.

The state vectors are transmitted twice as often as required for the SID calculation to be precise. Hence a state vector is valid two times the period signalled by the Time-To-Next (TTN) field in the *SatelliteStateVectors* AVP. The state vector can be considered valid for an extra 30 seconds after double the TTN period has expired.

9.4.8 RNC_SID_Update: (PARALLEL PROCESS)

The *RNC_SID_Update* parallel process maintains the RNC_SID variable, and hence SID, used by the algorithm. It monitors the forward link for any timing corrections that might be arriving from the RNC. If a timing correction arrives with a value larger than ±120 microseconds (or 4 symbols on a 33,6 kBd bearer), when SYNC equals UE_POS the SYNC variable is set to NO.

The *TimingCorrection* AVP provides a correction value for SID in units of one-quarter of 33,6 kBd symbol periods in 2's complement signed notation, i.e. in units of approximately 7,5 µs. A positive number indicates that the SID should be increased by this amount from its current value. If a new *TimingCorrection* AVP is received before the new value of RNC_SID has been used, the second command overrides the first, rather than being added to it. If a *TimingCorrection* AVP results in SID going out of its valid range of 0 to 80 ms, it shall be clipped to remain within this range.

If the UE is in Primary Timing mode, (SYNC = UE_POS) or during registration attempts in primary timing mode (executing UEPOS_Available), then the UE shall ignore any timing corrections from the RNC if they are within the allowed +/- 4 Symbols.

Two formats of the *TimingCorrection* AVP exist: one single byte and one dual byte. The functionality of the two formats is identical. The RNC shall choose between them based on the magnitude of the actual measured timing offset.

9.4.9 Elapsed_Time_Monitor: (PARALLEL PROCESS)

This parallel process tracks the time elapsed between transmissions on the return link. This process shall ensure that the interval between transmissions do not exceed an allowed period without the SYNC variable being reset to "NO".

The *TimingCorrectionUpdateInterval* AVP is signalled by the RNC in the global beam. For all UE Classes, if this interval is exceeded the UE shall set the SYNC variable equal to "NO", and hence force the UE to do an untimed random access again. The satellite drift is UE Class independent.

In addition, if the UE Class is different from Land Class, the UE shall fulfil a second interval, the UE Class dependent interval:

Land-Mobile: 1 Minute

Maritime: 2 Minutes

Aeronautical: 8 Seconds.

If the UE Class dependent interval is exceeded, the SYNC variable shall be set to "NO" as in the non class dependent case.

This parallel process is only necessary if synchronization was not achieved by the use of UE position.

9.4.10 Beam_Delay_Range_Update: (PARALLEL PROCESS)

Extracts the information from the *MaxDelayAndDelayRange* AVP and stores the values in the Beam_Max_Delay and Beam_Delay_Range variables. Sets beam_delay_valid flag to OK If the use-rctc-primary bit is FALSE in the received *MaxDelayAndDelayRange* AVP and the primary method is used (SYNC = UE_POS), then the UE shall set SYNC = NO.

9.4.11 Get_UEPOS (FUNCTION)

Input: SYNC

Output: UE position in ECEF format (metres)

The conversion of position (in terms of latitude and longitude) to ECEF shall be in accordance with the WGS-84 reference ellipsoid.

Check_Value set to OK if position is still valid.

If (SYNC = NO)

Estimate UE position using e.g. GPS.

IF (UE_Class = Land)

The UE shall attempt to acquire the position for up to 30 seconds before registering without a new GPS Fix for the purpose of using Primary Timing return channel timing.

If, after waiting, there is no new position fix available, the UE may use a valid previous position for the purpose of Return Channel Timing alone. Here, the definition of a valid previous position is one which on the immediately preceding occasion when it was used, including on the previous switch-on, resulted in the UE successfully remaining in primary timing mode. The UE shall be capable of remembering such a position for a period of up to 1 month.

There may optionally be a UE MMI which allows the user to answer yes/no to the following question:

"Can I re-use the previous position?"

If the answer is "yes", the UE may use a valid previous position as above; if the answer is "no", then it shall not (Get_UEPOS shall return without a position). If there is no MMI interface for this, the "answer" is implememtation-dependent.

Manufacturers should note however that attempting to use Primary Timing mode when the UE has in fact moved will normally result in the Register message colliding repeatedly. Access will then be delayed until 3 times the Register timeout period, resulting in an additional delay to access the network of ~20 seconds compared to using Secondary timing mode immediately. Similarly, the use of Secondary timing mode when not required would typically result in an additional network access delay of ~20 seconds due to the shortage of Untimed contention slots, and the higher collision probability in them. Therefore, a correct answer from the user is not absolutely necessary from the network perspective, but from the user perspective it does reduce the network access time by about 20 seconds.

Else

Time out after 30 seconds, if the UE position could not be estimated.

End if

If (UE_Class = Land and SYNC =! NO)

Use the initial position estimate

If (UE_Class = Land_Mobile and SYNC =! NO)

If (UE position estimate is older than 30 Seconds)

Update UE position using e.g. GPS.

Time out after 20 seconds if a new UE position could not be estimated.

If (UE_Class = Maritime and SYNC =! NO)

If (UE position estimate is older than 1 minute)

Update UE position using e.g. GPS.

Time out after 20 seconds if a new UE position could not be estimated.

Get_UEPOS (FUNCTION) *(continued):*

If (UE_Class = Aeronautical and SYNC =! NO)

If (UE position estimate is older than 2 seconds)

Update UE position using e.g. GPS.

Time out after 20 seconds if a new UE position could not be estimated.

If (A GPS fix was found available)

Check accuracy of GPS estimate is OK. Some GPS chipsets will be able to give an Error estimate directly. If this is the case, then the error estimate shall be the 99th percentile. If the GPS chipset does not support this feature then the UE shall calculate the estimated error by using the formula below. The URA and UERE are parameters which is contained in the standard GPS NMEA message format. If an updated UERE is available from the GPS Chipset then this shall be used, if that is not the case the UERE parameter shall be set to 12 metres.

If (UERE > URA × 3)

Error = PDOP × UERE

Else

Error = PDOP × URA × 3

End if

If (Error > 1 500 metres)

Let Check_Value = NOT_OK (or a more stringent error reading as provided by GPS chip-set, if appropriately scaled by probability) # Discard GPS estimate

IF a time out has occurred: Let Check_Value = NOT_OK

9.4.12 Calc_SID_UEPOS (FUNCTION)

Input:

StateVec: Satellite State vectors

UE_ECEF_POS: UE position in ECEF coordinates.

Beam_Max_Delay: Maximum delay possible in presently used satellite beam.

This routine is not allowed to execute unless beam_delay_valid is set to OK.

Output:

SID in microseconds

For a UE operating in secondary timing mode on a beam-to-beam handover, if MaxDelay has changed, the overall target frame timing that the RNC is expecting has changed. Therefore, the UE is expected to change SID in line with the change of MaxDelay. For example, assuming the UE is in the SYNC=NO_UEPOS state in the regional beam, with MaxDelay = 20 ms, and SID = 3,5 ms, if the UE is now handed over to the narrow beam with MaxDelay = 25 ms, then the UE shall increase its SID value by 2 × (25 - 20) = 10 ms, to 13,5 ms.

Calculate: $$SatPos(X,Y,Z)_{ECEF} = \begin{cases} X = 42164000 \cdot \cos\left(\frac{Sat_{Long} \cdot \pi}{180}\right) + \left(X_{StateVector} \cdot 488\right) \\ Y = 42164000 \cdot \sin\left(\frac{Sat_{Long} \cdot \pi}{180}\right) + \left(Y_{StateVector} \cdot 488\right) \\ Z = Z_{StateVector} \cdot 488 \end{cases}$$

Calculate: $$\text{Distance} = \sqrt{\left(Sat_X - UE_X\right)^2 + \left(Sat_Y - UE_Y\right)^2 + \left(Sat_Z - UE_Z\right)^2}$$

Calculate: $$Delay = \frac{\text{Distance}}{299792458}$$

Calculate: $$SID = 2 \cdot \left(Beam\_Max\_Delay - Delay\right)$$

NOTE 1: The speed of light is taken as 299 792 458 m/s.

NOTE 2: The value of Beam_Max_Delay sent refers to the one-way delay within a beam, whereas the value of Beam_Delay_Range refers to the round-trip delay.

NOTE 3: MaxDelayAndDelayRange value will not change during the lifetime of a BCt (i.e. it only changes on Handover or -less likely- if beams on the spacecraft and/or spot beam maps are resized, the latter would always require the BCt to be taken down for the change to be applied).

9.4.13 Check_SID_Calc (FUNCTION)

Input:

Previously calculated SID value

Beam_Delay_Range

Output:

Check_Value indicating if the SID is valid for use

```
Check_Value = OK
If (SID < 0)
    Check_Value = NOT_OK
If (SID > (Beam_Delay_Range))
    Check_Value = NOT_OK
If State_Vector_valid = NOT_OK or beam_delay_valid = NOT_OK
    Check_Value = NOT_OK
```

9.4.14 Do_RACH (FUNCTION)

Input: SID

Output: Time_Elap

Call TX routine with SID value as input. Burst to be transmitted in the middle of slot, hence with 180 microseconds guard time in each end of burst. The TimingRequired bit shall be asserted. The RNC assumes a processing latency in the UE of 80 milliseconds. Hence the effective TX time relative to the UW on forward link is 80 milliseconds plus the SID. For further details see TS 102 744-2-1 [6]. The 80 milliseconds are referenced at the UE antenna. The overall burst timing accuracy shall be better than ±10 microseconds. If (successful in transmitting a burst)   Let Time_Elap = 0 Nothing within the algorithms can keep the UE from transmitting a burst. However, transmission could fail due to external factors such as UE overheating.

9.4.15 Wait_RNC_Resp (FUNCTION)

Input: N/A

Output: Check_Value, signalling if a timing correction was received or not

Wait for timing correction arriving on the forward link.
 	
In the case of an untimed random access being performed with an AL registration PDU, this times out after 30 seconds. Otherwise time out according to status-ack-timeout
 	
If (Timed out at AL registration)
 	
    Check_Value = NOT_OK
 	
Else
 	
    Check_Value = OK

9.4.16 Check_RNC_Resp (FUNCTION)

Input: RNC_SID, containing the measured timing offset from the RNC

Output: Check_Value, signalling if the calculated SID is good enough for use

If (RNC_SID > 120 µsec(= 4 T1 symbols))
 	
    Check_Value = NOT_OK.
 	
Else
 	
    Check_Value = OK.

9.4.17 Calc_Req_Con_Slots (FUNCTION)

Input: Beam_Delay_Range

Output:

Req_5ms, giving how many 5 millisecond slots are required for an un-timed random access burst

Req_20ms, giving how many 20 millisecond slots are required for an un-timed random access burst

$$\text{Req\_5ms} = \text{Beam\_Delay\_Range}$$

$$\text{Req\_20ms} = ceil\left(\frac{Beam\_Delay\_Range}{4}\right)$$

Annex A (informative): Process Variables And Objects

The Bearer Control process has a number of constants, variables and tables associated with it. These are defined in the following clauses.

A.1 Bearer Control Constants

The Bearer Control process requires the definition of the following constants shown in Table A.1.

Table A.1: Bearer Control Constants

Constant/Variable	Meaning	Value
RTT	The typical round-trip time including encoding and decoding delays	RTT
MinRTT	Guaranteed minimum round-trip time, being only the air-interface time for geosynchronous orbit to sub-satellite point	480 ms
MaxAllocTime	The maximum time required for the RNC RRM to respond to a capacity request on a received Status SDU, to a change in the return schedule allocation	160 ms
RetRetuneTime	The time a UE takes to retune its transmitter to a Bearer in a new 200 kHz sub-band. (Within a sub-band the UE can retune on a burst by burst basis)	20 ms

Here, RTT = 668 ms + (10 ms × *max-delay* in *MaxDelayandDelayRange* AVP). Equivalently, RTT = 428 ms + (2 × *maximum delay*) as defined in the *MaxDelayandDelayRange* AVP in ETSI TS 102 744-3-1 [8]. This includes 40 ms processing delay for each of Transmit/ Receive, RNC/UE, and assumes an RNC located at approximately 20 degrees elevation (this is a worst-case RNC position: for RNCs at lower latitudes, performance will be slightly better).

Table A.2 describes the parameters used by the UE to determine and signal the forward bearer number to the RNC, if instructed to do so via the *SendFBearer* parameter.

Table A.2: Parameters for a Forward bearer identification

Parameter	Meaning
SendFBearer	This boolean indicates whether the UE should inform the RNC which Forward Bearer that the UE is tuned to. This is used when the UE fails to receive a Forward Bearer, times-out and retunes to a different Forward Bearer. It is also used when the RNC initiated the retune operation, as an acknowledgement
BearerNo	The Bearer Number of the Forward Bearer within the Bearer Control at the RNC (FBearer received in Bulletin Board). This variable can be set to "unknown".

A.2 Connection Related Parameters

Table A.3 describes the connection related parameters.

Table A.3: Connection Parameters

Parameter	Meaning
BconnId	This is a unique identifier for the Bearer Connection. Common Signalling Connections do not have BConnIDs and therefore have this parameter set to NULL. This is assigned by the RNC.
QoS	The Quality of Service for this connection. The full range of QoS parameters are not known by the UE. The following values are set by the *Type0QoS* AVP: RetL - the desired latency in the return direction, default 2,4 sec. This is used to calculate data urgency in Criteria A & B. Set from the return-target-latency field RetMeanRate - the mean rate in the return direction, default 640 bytes/sec. This is used to calculate THeadDelivery and TTailDelivery, the expected delivery times. Set from the return-mean-rate field RetPeakRate - the peak rate in the return direction, default 2 560 bytes/sec. Used to calculate the maximum number of in-flight bytes in a RTT, and to estimate the minimum time to send a certain number of bytes. Set from the return-peak-rate field RetDiscardLatency - the time after which untransmitted segments are discarded rather than transmitted, default 60 sec. Used in the Connection Layer. Set from the return-discard-latency field.
ControlQ	The queue length of the connection queue including Bearer Control process overheads. The initialization value is 0.
THeadDelivery	The delivery time for the head of the queue, as calculated in ETSI TS 102 744-3-4 [9], clause 5.2.
TTailDelivery	The delivery time for the tail of the queue, as calculated in ETSI TS 102 744-3-4 [9], clause 5.2.
HeadDataSize	The number of bytes (remaining) in the PDU at the head of the queue, that is, the remaining part of a PDU currently being segmented.
SegStart	A boolean indicating whether the data at the head of the queue is the start of a Bearer Connection segment (i.e. a bom or ssm PDU). For Common Signalling connections this will always be TRUE. Initial value TRUE.
UnSegmentable	The number of bytes at the head of the queue that cannot be segmented. This is either for signalling data that cannot be segmented, or the Bearer Connection overhead: if a Bearer Control request for less than this is handed to the Connection layer, it cannot be serviced because the overhead exceeds it.
RNCControlQ	The information that the RNC should have (or should receive if the last Status SDU sent is in flight) on the queue length including Bearer Control process overheads. The initialization value is 0.
RNCTHeadDelivery	The information that the RNC should have (or should receive if the last Status SDU sent is in flight) on the delivery time for the head of the queue. Updated when a slot is used using RNCDeliverRate, and set to THeadDelivery when a Status SDU is sent. Used to determine the expected response time.
RNCTTailDelivery	The information that the RNC should have (or should receive if the last Status SDU sent is in flight) on the delivery time for the tail of the queue. Used to calculate the RNCDeliverRate.
RNCDeliverRate	The delivery rate, based on RNCTHeadDelivery and RNCTTailDelivery, that both the RNC and the UE will use for updating RNCTHeadDelivery.
TStatusSDU	The time at which the last Status SDU was sent to the RNC. It is used to process an incoming Status SDU acknowledgement, and also to trigger a new Status SDU.
StatusSDUCont	A boolean indicating whether the last Status SDU was sent in a contention slot.
TReportTime	The time at which a Status SDU should be sent to the RNC calculated from THeadDelivery and HeadDataSize.
TLastTx	The time at which the last transmission was sent in either contention or reserved slot. This is a per-connection variable initialized at the creation of the connection to (Tnow - MinContStatusDelay). This is done such that the arrival of the first data PDU would trigger a Status SDU to be sent without waiting for MinContStatusDelay.
AllocationSize	This is the number of bytes usually allocated to this connection (including Bearer Connection overhead, but excluding Bearer Control overhead). The parameter is set by the *AllocationSize* AVP. If the *AllocationSize* AVP is not received when the connection is established, the default values defined in ETSI TS 102 744-3-1 [8] are used (32). It will normally be changed as the link adaptation changes.
Qdiff	When both the difference between ControlQ and RNCControlQ exceeds QDiff, and the queue size is large, then a Status SDU is sent. The parameter is set by the *QDiff* AVP, and has a default value of 1 024. It is used to trigger Criterion B.
StatusSeqNum	The last sequence number sent in a Status SDU. Numbers are in the range 0 to 15, incremented each time a Status SDU for a connection is sent and wrap round so that 0 follows 15. The initialization value is 0.
UnAckStatusCount	The number of consecutive unacknowledged *Status* SDUs.

Parameter	Meaning
AckMissed	A boolean value set to TRUE when an Acknowledgement for a Status SDU has not been received (status-ack-timer has expired) thus causing the Status SDU to be resent via Criteria A or B. The initialization value is FALSE.
ResMissed	A boolean value set to TRUE when a reservation for this Bearer Connection has not been received causing the reserved-slot timer to expire. The initialization value is FALSE. Triggers the Status SDU to be resent via Criteria A or B if set to TRUE.
MinResWait	When multiplied by ResWaitMultiplier, this gives the minimum time to wait for a reserved slot before resending a Status SDU. The parameter is set by the *MinResWait* AVP with a default value of 6 seconds, from the min-res-wait field.
RandomisingLevel	The randomizing level the UE is operating in. Level 0 means no randomizing. Level n means a SelectedFrame up to (FrameRandomiser × 2^(1 + RandomisingLevel)) is selected. The initialization value is 0. Used to define the UE contention-slot back-off behaviour.
SelectedFrame	A number, selected at random from a range of values determined by RandomisingLevel or RetryCount (provided by the Connection sub-layer), and decremented each time a Return Schedule is received with at least one contention slot. A countdown counter controlling the UE contention-slot back-off behaviour.

A.3 Process Constants and Variables

Table A.4 shows the constants and variables that this process uses. Most constants are "soft" and may be updated using the Bearer Control SDUs.

Table A.4: Process Constants and Variables

Constant/Variable	Meaning
Tnow	This special variable indicates the current time.
FracPeakDataVol	When the queue length has fallen, this value (usually between 0 and 1) is used to calculate the minimum queue length outstanding for a Status SDU to be sent. The value is set by the *FracPeakDataVolAndLFrac* AVP. Default value 0,5; used in Criterion B. Set from the frac-peak-data-vol field.
TackWait	Used to set the status-ack-timer (wait for a Status SDU Acknowledgement). The value is set by the *StatusAckControl* AVP, default 240 ms, set in the t-ack-wait field, used in the Create-Slot procedure to set the status-ack-timer.
MaxUnAckStatus	The maximum value for the unacknowledged Status Acknowledgement counter UnAckStatusCount. The value is set by the *StatusAckControl* AVP, default value 8, set in the max-unackstatus field.
ReportControl	Usually between 0 and 1 this parameter controls when a Status SDU will be sent; 0 indicates the earliest possible time and 1 indicates the latest possible time, it can be varied according to the level of congestion. Values higher than 1 delay the sending of Status SDUs beyond the latest time to meet the QoS but would allow the contention capacity required to be reduced in Bearer overload situations. The value is set by the *ReportControl* AVP, default value 0,3125, set in the ReportControlParam field.
ResWaitMultiplier	This parameter is used by the RNC in congestion conditions to change the time that the UE waits for reserved slots before timing out and resending a Status SDU. It is used in the transmit schedule processing algorithm., and the Create_Slot procedure The value is set by the *ResWaitMultiplier* AVP, default value 1, from the ResWaitMultiplierParam field.
Lfrac	A value between 0 and 1,875 which, when multiplied by the latency, is used to determine a time offset; it is set ≤ 1 to meet the QoS. It is used to control the weighting that the algorithms give to latency, in both Criteria A and B to calculate UrgentData. If the actual time at the head of the queue is more urgent than the time that the RNC has by a period greater than this calculated time offset, then a Status SDU may be triggered. The value is set by the *FracPeakDataVolAndLFrac* AVP, default value 0,5, from the l-frac field.
RetCtrlSegOverhead	The number of bytes of Bearer Control overhead per segment in the return direction. It is used to estimate segmentation overheads and therefore estimate the total capacity required to service Bearer Connection queues. This is 4 bytes if no length field (which will be the most common situation in the return direction) but including CRC.
MinOfferedSize	The smallest number of bytes offered to a Bearer Connection. The value is set by the *SlotSizeControl* AVP in the min-offered-size field, default value 5.

Constant/Variable	Meaning
MinContStatusDelay	This is a minimum delay between receiving Bearer Connection status information and sending a Status SDU in a contention slot. In the case when the data being sent is ARQ data, having a minimum delay gives a short time in which the RNC can reserve a slot for the UE in order to reduce contention slot usage. The value is set by the *MinContStatusDelay* AVP in the MinContStatusDelayParam field, default value 80 ms.
MaxRandomisingLevel	The maximum number to which RandomisingLevel can rise. The value is set by the *RandomisingControl* AVP in the max-randomizing-level field, default value 4.
FrameRandomiser	The number of frames over which randomizing is to take place at Level 1. The value is set by the *RandomisingControl* AVP in the frame-randomizer field, default value 2.
SpotBeam	The Spot Beam number of the RNC that the Bearer Control's Bearers are tuned to (spot-Beam-ID field received in *BulletinBoard)*. This variable can be set to "unknown".
BctlID	The Bearer Control identifier of the Bearer Control at the RNC that the UE's Bearer Control's Bearers are tuned to (BCtlID received in *BulletinBoard*). This variable can be set to "unknown".
Constant-bit-rate	An attribute set per connection: for a constant bit-rate connection, CN.constant-bit-rate is set TRUE, so that Status SDUs are not sent to the RNC for constant-bit-rate connections.

History

Document history		
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